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AUTHOR	Smith, Sylvia Barrus
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ABSTRACT

This study evaluated the effectiveness of phonological awareness instruction with 61 kindergarten children in two schools who had been identified as low in phonological awareness. The children received either: (1) instruction at the phoneme level only, (2) instruction at the onset-rime level before instruction at the phoneme level, or (3) no intervention. Fourteen additional participants in a non-equivalent condition received a subset of tests. The interventions were delivered in 15-minute sessions, four times per week for nine weeks, in groups of three to four children. Group results were compared with pre/post and slope analyses. Children in the experimental groups performed reliably better on phonemic segmentation fluency, onset recognition fluency, and blending at posttest than children in control groups. No reliable differences between groups were found on phonological awareness measures that required generalization or on rapid retrieval on alphabetic understanding measures. Instruction at the phoneme and onset-rime levels were equally effective and efficient. (Contains 92 references.) (DB)

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AN EXAMINATION OF THE EFFICACY AND THE EFFICIENCY OF PHONOLOGICAL AWARENESS INSTRUCTION FOR PREREADERS AT-RISK OF READING FAILURE

by

SYLVIA BARRUS SMITH

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Title: AN EXAMINATION OF THE EFFICACY AND THE EFFICIENCY OF ONOLOGICAL AWARENESS INSTRUCTION FOR PREREADERS AT-RISK OF READING FAILURE

Approved: _____
Dr. Deborah C. Simmons

Research indicates that early identification and early intervention in carefully designed phonological awareness instruction may enhance subsequent reading acquisition of children at-risk of reading failure. Within their own classroom, 61 kindergarten children in two schools who had been identified as low in phonological awareness were randomly assigned to one of three groups that received (a) instruction at the phoneme level only, (b) instruction at the onset-rime level before instruction at the phoneme level, or (c) no intervention. Fourteen additional participants in a non-equivalent condition received a subset of tests. The interventions were taught in 15-minute sessions, four times per week for nine weeks, in small groups of three to four children.

Group results were compared with pre/post and slope analyses. Children in the experimental groups performed reliably better on phonemic segmentation fluency, onset recognition fluency, and blending at posttest than children in control groups. No reliable differences between groups were found on phonological awareness measures that required generalization, or on rapid retrieval or alphabetic understanding measures. the experimental group that received instruction directly at the phoneme level had a significantly steeper rate of growth on phonemic segmentation fluency than the control group but not than the onset-rime group. No reliable differences between groups were found on rate of growth for onset recognition fluency. Instruction at the phoneme and onset-rime levels were found equally effective and efficient. Findings indicated that kindergarten children low in phonological awareness can benefit from instruction at the phoneme level prior to full development of alphabetic understanding. Implications for current practice indicate that instructional time can be maximized for children at-risk of falling behind their peers in reading acquisition with well-designed phonological awareness curricula at the phoneme level.

CHAPTER I

STATEMENT OF THE PROBLEM

In our society, reading is an empowering skill. Consequently, reading disabilities and reading delay are highly correlated with negative personal and societal consequences including juvenile delinquency, school drop out, and unemployment. Students at-risk for reading disabilities need effective and efficient early interventions because those children who are not good readers at the end of first grade have a high probability of remaining poor readers in subsequent grades (Juel, 1988). Traditional reading remediation for poor readers is often inadequate and, as a result, the literacy gap between good and poor readers widens over time (Stanovich, 1988a). However, for children who appear consigned to reading failure and its enduring consequences, powerful convergence in phonological awareness research suggests solutions for the prevention of reading disabilities.

Background

Nearly one-third of children fail to understand the phonemic structure of our language or do not possess sufficient levels of phonological awareness to initiate the reading acquisition chain (Adams, cited in Brady, Fowler, Stone, & Winbury, 1994). Results from phonological processing research further indicate that deficits in processing the phonological features of language explain a significant proportion

of beginning reading problems and correlated difficulties in reading comprehension, background knowledge, memory, and vocabulary differences (Liberman & Shankweiler, 1985; Mann & Brady, 1988; Rack, Snowling, & Olson, 1992; Torgesen, Wagner, Simmons, & Laughon, 1990; Wagner & Torgesen, 1987).

Factors Associated with Low Performance in Phonological Awareness

Two prominent factors are associated with low levels of phonological awareness: (a) phonological processing deficits within the child (e.g., awareness and rapid naming), and (b) environmental deficits that result in diminished opportunity to learn (Adams, 1990b). The environmental deficit can be "taught away" (Adams, 1990b); whereas, recent research indicates that the within-child deficit is more stable than earlier research indicated (Ackerman & Dykman, 1993; Blachman, 1994; Korhonen, 1995; Torgesen, Wagner, & Rashotte, 1994). Although the stability of the deficit does not mean that the deficit is not amenable to instruction, it does suggest that quality of instructional design may be more critical for students with a "within-child" deficit, particularly if the child has deficits in both areas of phonological processing (e.g., awareness and rapid naming) (Ackerman & Dykman, 1993; Blachman, 1994; Felton, 1993; Korhonen, 1995; Torgesen et al., 1994).

Recent Intervention Emphasis on Low Performers

In short, difficulties with awareness, coding, and retrieval of verbal sounds have powerful and long-reaching effects in reading. Although the most encouraging lines of research give strong evidence that significant gains in phonological awareness can be achieved with teaching and that the gains in phonological awareness directly affect the ease of reading acquisition and reading achievement, much of the earlier research was done with normally achieving children (Smith, Simmons, & Kameenui, 1995). Recent intervention research reflects a shift to children with low levels of phonological awareness (Brady et al., 1994; O'Connor, Jenkins, Leicester, & Slocum, 1993; O'Connor, Jenkins, & Slocum, 1995; Slocum, O'Connor, & Jenkins, 1993; Torgesen, Morgan, & Davis, 1992; Torgesen & Davis, in press).

Statement of the Problem

Although significant improvement in phonological awareness and reading has been documented across several decades of intervention research, some children with low pretest scores in phonological awareness do not make progress in spite of instruction (Torgesen et al., 1992; Torgesen et al., 1994). A major source of difficulty for students low in phonological awareness appears to be their ability to process language at the phoneme level (Lyon, 1995). Importantly, it is manipulations (i.e., segmenting and blending) at the phoneme level that facilitate reading acquisition (Torgesen et al., 1994; Wagner & Torgesen, 1987).

Phoneme-Level Difficulty of Children With Low Phonological Awareness

Research has not established if phonological awareness at the phoneme level is dependent upon letter knowledge or if the difficulty of language at the phoneme level can be mediated by instructional variables before letter knowledge acquisition. Moreover, the relations among instructional variables, development, and within-child deficits are not fully delineated by current research (Slocum et al., 1993).

Research is needed to unpack instructional complexity at the phoneme level. Specifically, what features contribute to complexity in phoneme segmentation? Will teaching the onset-rime level before the phoneme level mediate complexity, compared to teaching the phoneme level directly (Slocum et al., 1993)? In addition, will scaffolding the articulatory features of words mediate task complexity at the phoneme level? Examples of scaffolding involve using words that begin with continuants at the time of initial instruction in new tasks and introducing single phonemes prior to phoneme clusters (Caravolas & Bruck, 1993; Gonzalez & Garcia, 1995; McBride-Chang, 1995; Stahl & Murray, 1994; Treiman, 1985; Treiman & Weatherstone, 1992). Thus, because "the core deficit responsible for the majority of cases of reading is at the most basic level of the language system---the level of the phoneme" (Lyon, 1995, p. 3), it is important to understand dimensions that mediate complexity at the phoneme level.

Ambiguities in Instructional Design Knowledge

Despite significant advances in understanding the causal and reciprocal relation between phonological awareness and reading acquisition, ambiguities exist in how to design optimal instruction. A variety of instructional formats and sequences have been used in extant phonological awareness research. Yet, the most effective and efficient methods for teaching phonological awareness have not been established. The following instructional design issue is discussed as context for the dissertation study.

> Which level of phonological size is more efficient to begin segmentation and blending instruction: onset-rime, or phoneme?

Words can be segmented into different sized units: (a) syllable (easiest), (b) onset-rime (easy), and (c) phoneme (most difficult). Although empirical evidence converges on the importance of manipulating sounds at the phoneme level (Wagner, 1988; Wagner & Torgesen, 1987), the design features and optimal sequence for developing phonemic-level ability have not been established empirically for students at-risk for reading disabilities.

Current theoretical explanations of the relation between the phoneme level and reading acquisition suggest that awareness at the phoneme level appears dependent upon concurrent acquisition of alphabetic understanding (Bowey, 1994; Bowey & Francis, 1991; Kirtley, Bryant, MacLean, & Bradley, 1989; Stanovich, 1994). In fact, although research has established that phonological awareness (i.e., inclusive term for all sizes of units including syllables and onset-rimes) can develop

prior to reading instruction, a current research issue is whether phonemic awareness (i.e., specific term for individual sound units) is developed prior to or concurrent with reading instruction (Bowey, 1994; Bowey & Francis, 1991; Kirtley et al., 1989).

Both blending and segmenting are prerequisite phonological awareness skills for reading acquisition. The dissertation focused on segmentation for two research-based reasons. First, segmentation has a high correlation with beginning reading (Torgesen et al., 1994) and if developed as a prerequisite skill to reading increases the ease of reading acquisition (Smith et al., 1995). Second, segmentation appears to be more difficult for students low in phonological awareness than blending (O'Connor et al., 1993; Torgesen et al., 1992, Torgesen & Davis, in press). Consequently, the dissertation study emphasized segmentation but taught segmentation and blending, concurrently.

Purpose of the Study

Questions to Be Addressed

The purpose of the dissertation was to extend current knowledge on how to teach phonological awareness by addressing the following question: Is it more efficient and effective to teach onset-rime segmentation as a precursor to teaching phonemic segmentation than to teach phonemic segmentation directly? (Adams, 1990a; Bowey, 1994; Bowey & Francis, 1991; Fowler, 1991; Kirtley et al., 1989; Slocum et al., 1993; Treiman, 1992). Two methods of phonemic segmentation

instruction that vary in a single design feature (size of phonological unit of instruction) were compared for significance of effects on efficacy and efficiency of performance. The single design feature that was manipulated was the size of phonological unit, phoneme and onset-rime. An instructional method that teaches phonemic segmentation at the phoneme level was compared to an instructional method that teaches phonemic segmentation starting at the onset-rime level and preceding to the phoneme level.

Proposed Outcomes

Proposed outcomes of the study included: (a) extension of the research base identifying efficient and effective methods for teaching phonemic awareness to prereaders at-risk of reading failure, (b) articulation of the relation between instructional design principles and efficiency, efficacy, and intensity in phonological awareness instruction for prereaders at-risk of reading failure, and (c) data for future profile analyses of individual children's response to phonological awareness instruction through formative and summative assessment.

Importance of the Study

The present instructional design study was driven by Kameenui's (1993) articulation of the tyranny that time exerts over students who may be falling behind each day, and Simmons' (1992) notion of "reading disability as an acute condition with a critical intervention period" (p. 68). Because the gap between good and

poor readers widens exponentially (Stanovich, 1986) and because phonemic segmentation is only one of several emergent literacy skills prerequisite for reading acquisition, efficiency of instruction is critical for children at-risk for reading failure.

Furthermore, data that indicate the stability of poor reading performance (Juel, 1988) coupled with significant success of early phonological awareness instruction on subsequent reading achievement point to the kindergarten year as a critical intervention year. The dissertation sought to add a modest, albeit significant piece of knowledge that has not been established: What size of phonological unit instruction more effectively and efficiently improves the phonemic segmentation ability of kindergarten-age children with phonological awareness deficits?

Conceptual Framework

The conceptual framework of the dissertation study integrated empirical evidence from areas of research such as linguistics, child development, speech and language pathology, reading disabilities, and instructional design, and was anchored theoretically and empirically to eight areas of convergence.

1. Phonological deficits explain a large majority of reading disabilities (Adams, 1990a; Liberman & Schankweiler, 1985; Mann & Brady, 1988; Spector, 1995; Stanovich, 1985, 1986, 1988a, 1988b; Wagner, 1988).

2. A causal relation exists between phonological awareness and reading acquisition (Adams, 1990a; Mann & Brady, 1988; Stanovich, 1985, 1986, 1988a, 1988b).

3. Because of the established causal relation to reading, it is important to identify early and intervene early in phonological awareness (Blachman, 1994; Lyon, 1995; Torgesen et al., 1994)

4. Blending and segmenting are necessary but insufficient prerequisites for reading acquisition (Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1991; Spector, 1995).

5. A strong relation exists between phoneme-level abilities and reading (Wagner, 1988; Wagner & Torgesen, 1987).

6. Although the phoneme is at the core of reading disabilities, phoneme complexity can be mediated by scaffolding the complexity of phonologic features of words (Lyon, 1995; Stahl & Murray, 1994).

7. Because of developmental constraints, the onset-rime unit, as a size of phonological unit between syllable and phoneme, appears to be more accessible than the phoneme level for young children (Bowey & Francis, 1991; Fowler, 1991; Kirtley et al., 1989; Treiman, 1992).

8. Phonological awareness is teachable and promoted by attending to instructional design variables such as scaffolding tasks, materials and amount of teacher assistance across a continuum of difficulty (Smith et al., 1995).

Attention to linguistic complexity is derived from theory that poor quality of perception, coding, and retrieval explains a large portion of differences in learning to read. When instruction is scaffolded (e.g., gradual and intentional adjustment of task difficulty) by decreasing the complexity of phonologic features of words, the problematic aspect of learning to read (e.g., phonological features of language) can be mediated.

Definitions of Terms

The research literature of phonological awareness entails highly technical language. The following definitions are offered as a guide for the subsequent discussion of these complex concepts.

Definitions

Articulatory features of phonemes refers to how and where sounds are produced and specifically, whether the sound can be elongated (continuants) or whether the sound cannot (stops).

Phonological processing. The use of phonology or sounds of language to process verbal information in oral or written form in short- and long-term memory (Wagner & Torgesen, 1987) is referred to a phonological processing. Components include awareness and coding (i.e., coding sounds for storage in memory and retrieval of sounds from memory codes) of verbal information only (Cornwall,

1992; Hurford, Darrow, Edwards, Howerton, Mote, Schauf, & Coffey, 1993; Torgesen et al., 1990; Vellutino & Scanlon, 1987a; Wagner & Torgesen, 1987).

Phonological awareness refers to the conscious ability to detect and manipulate sounds (e.g., move, combine, and delete) as well as access to the sound structure of language. Phonological awareness is the awareness of sounds in spoken words in contrast to written words and includes all sizes of phonological units (e.g., syllables, onset-rimes, and phonemes), a relevant ability in learning that letters represent sounds. Two lines of research provide strong support that phonological awareness is part of a larger construct in coding and retrieving verbal information known as phonological processing (Hurford et al., 1993; Vellutino & Scanlon, 1987a, 1987b; Wagner, 1986, 1988; Wagner & Torgesen, 1987).

Onset-rime refers to two-part divisions of words between the initial phoneme or phoneme cluster (onset) and the final multiple phoneme unit (rime) (e.g., /br/ is the onset and /ight/ is the rime in bright).

Phonemic awareness is awareness of and the ability to manipulate discrete individual sounds (phonemes) that correspond to individual letters. Phonological awareness is used as the general term that refers to all sizes of sound units including phonemes; however, phonemic awareness will refer only to the phonemic level or smallest discrete sound unit, the most difficult unit to perceive and manipulate (Liberman & Shankweiler, 1985).

Linguistic complexity refers to word features that can be represented by gradations in size and by articulatory features of words. For example, word length,

size of the phonological unit, and consonant clusters can be dimensions of task complexity in phonological awareness (Stahl & Murray, 1994; Treiman & Weatherstone, 1992).

Delimitations of the Study

Delimitations involved: (a) participants, (b) components of phonological awareness, and (c) sequence of beginning reading instruction. Although extant research has documented that phonological awareness interventions improve reading acquisition across ability groups, the dissertation only considered students with significant delays in phonological awareness (Torgesen & Bryant, 1994b). This was done to examine the dimensions of instruction necessary to effect change in children for whom phonological awareness plays a particularly critical role. Moreover, the intervention taught only phoneme identification, blending, and segmenting. The intervention represented an early component of a year-long curriculum that would ideally include instruction in letter-sound correspondences and blending simple words after the introduction of auditory skills.

Overview of the Dissertation

The dissertation includes five chapters, references, and appendices. Chapter II includes: (a) a review of three literatures: phonological awareness and processing, effects of phonologic word features on phonological awareness task complexity, and interventions for prereaders low in phonological awareness, and (b)

a discussion of issues and methodologies to be addressed. Chapter III describes the methods to address the research questions and includes: (a) participant selection, (b) independent variables, (c) dependent measures, (d) procedures, and (e) design and data analysis. Chapter IV presents the results for: (a) descriptive statistics assessing comparability of groups at pretest, (b) descriptive and inferential statistics addressing the two research questions, and (d) descriptive and inferential statistics addressing fidelity of implementation. Chapter V addresses interpretation of results, limitations of the study, implications for phonological awareness instruction in kindergarten, and future research. The appendices include: (a) an example of a format added the original curriculum, (b) a form for rank ordering of emergent literacy activities in the control conditions, (c) an administration schedule of measures, (d) a fidelity of implementation checklist, (e) pretest and posttest correlation matrices.

CHAPTER II

REVIEW OF THE LITERATURE

Over the past several decades, considerable attention and empirical research have investigated the importance of phonological awareness to reading success. This body of research documents that phonological awareness facilitates understanding of how print maps to speech (i.e., alphabetic understanding), which in turn, facilitates fluent and accurate word recognition. Review of the literature provides understanding of interactions among phonological awareness deficits and phonological awareness task variables that affect children's response to instruction.

The chapter is divided into the following major sections: (a) the literature review methodology, (b) research examining the dimension of phonological processing and learner characteristics, (c) research examining the effects of word features on phonological awareness task complexity, (d) research examining the effects of phonological interventions for prereaders low in phonological awareness on phonological awareness development, and (e) research issues and methodologies to be addressed.

Literature Review Methodology

The literature review for the dissertation study extended a previous phonological awareness literature review conducted for the National Center to

Improve the Tools of Educators (NCITE): Synthesis of research on phonological awareness: Principles and implications for reading acquisition (Smith, Simmons, & Kameenui, 1995).

Review Methodology for the NCITE Synthesis

Sources were selected to represent a sample of relevant phonological awareness research published from Winter 1985 through Spring 1993. Literature reviewed included primary studies and secondary sources published in books and book chapters, and journal articles found in computer searches in the Educational Resources Information Center [ERIC] and Psychological Abstracts. Sources were included that met the following criteria: (a) published after 1985, (b) included participants with disabilities, (c) included children of ages preschool through grade eight, (d) employed criterion measures for phonological awareness, and (e) reported or summarized studies involving experimental and control group comparisons.

The range of journals included: Reading Research Quarterly, American Educational Research Journal, Journal of Educational Psychology, Exceptional Children, Journal of Experimental Child Psychology, Journal of Learning Disabilities, Learning Disabilities Quarterly, The Journal of Special Education, Remedial and Special Education, Education and Treatment of Children, and Journal of Reading Behavior.

In total, 28 sources were reviewed including 13 primary studies and 15 secondary sources. Further, the 13 primary studies included 7 training studies that

looked at the effect of phonological awareness intervention on phonological awareness, reading, and reading and spelling.

Literature Review Methodology of the Extended Literature Review

Purpose

The major purpose of the extended literature review was to examine phonological awareness interventions for prereaders low in phonological awareness and to identify issues and research methodologies that need to be addressed. In addition, to more fully understand individual differences in response to instruction, studies examining other variables that affect response to instruction were included: (a) research examining rapid naming deficit and its relation to phonological awareness and reading acquisition, and (b) research examining sources of phonological awareness task complexity.

Procedures and Data Sources

To extend the NCITE review, an ERIC search, a Psych Lit search, and a hand search of the same journals used in the NCITE review was conducted for sources published from Summer 1993 through Summer 1995. Descriptors included: phonological awareness, phonemic awareness, phonological processing, onset-rime, beginning reading, preschool children, kindergarten, beginning reading research, and interventions. In addition, references from relevant articles were followed, relevant

manuscripts in press were solicited, and chapters from relevant books published since 1989 were identified. Intervention studies were limited to those involving prereaders low in phonological awareness; whereas, learner characteristic studies included children of all ages. A similar procedure was conducted for the onset-rime literature. A total of 44 sources were reviewed, including 16 secondary sources and 28 primary studies. References are listed at the beginning of each of the three major research sections.

Dimensions of Phonological Processing and Learner Characteristics

The purpose for examining research on dimensions of phonological processing was to understand those dimensions that are amenable to instruction and those that affect learners' response to instruction. This was done to derive instructional implications for students who may experience difficulty in learning to read, and by that inform the instructional design of phonological awareness early interventions. The following section was restricted to studies examining dimensions of phonological processing. Moreover, phonological awareness dimensions were limited to phonological segmenting and blending. This section represents an overview of 24 sources including 9 secondary sources (Barinaga, 1996; Catts, 1993; Felton, 1993; Kamhi & Catts, 1989; Lyon & Chhabra, 1996; Smith et al., 1995; Stanovich, 1992, 1994; Torgesen et al., 1994; van Ijzendoorn & Bus, 1994), and 14 experimental studies (Ackerman & Dykman, 1993; Bentin, 1993; Bowey, 1994; Cornwall, 1992; Das, Mishra, & Kirby, 1994; Eden, Stein, Wood, & Wood, 1995;

Fawcett & Nicolson, 1994; Korhonen, 1995; Roodenrys & Hulme, 1993; Tallal, Miller, Bedi, Byrna, Wang, Nagarajan, Schreiner, Jenkins, & Merzenich, 1996; Walsh, Price, & Gillingham, 1988; Wolf, Bally, & Morris, 1986; Yopp, 1988). Included in the section are: (a) description of research on phonological processing dimensions and the relation of the dimensions to learner performance, and (b) the relation of the phonological processing dimensions to reading.

Dimensions of Phonological Processing and the Relation to Learner Performance

Extensive research has examined whether phonological processing is a general ability or a composite of highly related but independent dimensions of the construct of phonological processing (e.g., Wagner & Torgesen, 1987). Based on their review of phonological processing research, Wagner and Torgesen proposed a partial answer: To some degree, phonological ability is general across tasks. This conclusion is based on significant interrelations among the dimensions. Limited research has indicated that phonological processing includes two broad dimensions, coding (i.e., encoding and retrieval) and awareness (Kamhi & Catts, 1989; Smith et al., 1995). Findings from more recent research point to a different model. Evidence suggested that retrieval processes and awareness are independent (Torgesen et al., 1994) and that further research is needed to understand the relative independence of encoding to awareness and retrieval processes. From an instructional design perspective, knowing whether phonological processing is a general ability or highly correlated but independent dimensions of a construct has

the following instructional implications. If phonological processing is a general underlying ability, transfer across dimensions and components of dimensions would be expected. However, if phonological processing comprises related but independent dimensions, then the necessity of directly instructing each dimension and component would be expected.

Phonological Awareness

Awareness is less complex than encoding and retrieval in the demands it places on memory and processing. In addition, findings from a recent research synthesis indicated that phonological awareness is relatively independent of overall intelligence, a finding of particular relevance for students with reading disabilities (Smith et al., 1995). However, conclusions from a single recent study did not offer full support for that notion by indicating that phonological awareness may not be as independent of intelligence as extant research has suggested (Torgesen et al., 1994).

Phonological awareness tasks include rhyming, identifying or isolating beginning and ending sounds, blending, counting, segmenting, deleting, and word-to-word matching. Yopp (1988) categorized phonological awareness tasks by reliability and validity, correlations, factorial structure, and difficulty. Only 3 of 10 measures used in Yopp's analysis met stringent reliability criteria (coefficient of .90). The tests were highly interrelated indicating that the tests measured a similar construct, supporting construct validity. However, findings from a factorial analysis indicated that the tests loaded on two factors, except for rhyme and auditory

discrimination that minimally loaded on either factor. That means that rhyme and auditory discrimination may tap a similar but separate construct. Yopp's task analysis of similarities in cognitive requirements for tasks across and within each factor indicated that the cognitive requirement similar across tasks was manipulation of phonological units. The difference between the factors was the number of steps required, which means that tasks in Factor 1 put less of a load on memory than tasks in Factor 2. The two tasks that did not load highly on either factor, rhyme and auditory discrimination, do not require manipulations of units. Yopp's (1988) findings are specific to manipulation of sound units at the phoneme level in contrast to the onset-rime level.

Yopp's work at the phoneme level indicated the following continuum from easy to most difficult: rhyme, phoneme blending, word-to-word matching, sound isolation, phoneme counting, phoneme segmentation, and phoneme deletion. Current research extending Yopp's (1988) work is establishing that size of the phonological unit contributes to difficulty (Stahl & Murray, 1994). For example, onset-rime manipulation is easier than phoneme manipulations. For normally developing children, the easier tasks (those requiring fewer manipulations) at the easier levels of size develop earlier than the more difficult tasks (those requiring more manipulations) and the more difficult levels of size, often prior to formal reading instruction. Research has not established the extent to which task difficulty can be mediated by instructional variables. Nevertheless, children with low phonological awareness do not perform as well as their normally developing peers

across the continuum of task difficulty (Smith et al., 1995). However, all phonological awareness tasks are teachable, and children with deficits progress in specific task performance as the result of instruction promoted by attention to instructional variables (Smith et al., 1995)

Recent conceptualizations suggested a two-level hierarchical development of phonological awareness: (a) a holistic sensitivity to phonological structures, and (b) a fully explicit analytical awareness that includes ability to manipulate spoken words at the phoneme level (Bowey, 1994; Bowey & Francis, 1991; Stanovich, 1994; Torgesen & Davis, in press). Research has not fully established how phonological awareness develops, particularly the relation between maturation in language development and instructional experiences. Extant research has indicated that, for most children, phonological awareness of larger phonological units (e.g., compound words, syllables, onset-rimes) develops without formal systematic instruction (e.g., Liberman & Shankweiler, 1985). In contrast, phonemic awareness appears dependent upon concurrent acquisition of alphabetic understanding (Bowey, 1994; Bowey & Francis, 1991; Kirtley et al., 1989; Stanovich, 1994). Thus, one issue is: Is phonological awareness at the phoneme level dependent upon letter knowledge or can the phoneme level difficulty be mediated by instructional variables prior to letter knowledge acquisition? However, the relations among instructional variables, development, and within child deficits are not fully delineated by current research (Slocum et al., 1993).

Retrieval Processes

Cognitive processes used in retrieving information in long-term memory are a focus of current research (Ackerman & Dykman, 1993; Catts, 1993; Cornwall, 1992; Fawcett & Nicolson, 1994; Felton, 1993; Eden et al., 1995; Korhonen, 1995). Rapid naming is widely used to measure retrieval processes. The following discussion will be limited to measures that consist of naming a series of items randomly presented. Rapid naming tasks that are frequently used for measuring rapid naming deficits include previously known: colors, pictures of familiar objects, digits, and letters. Wolf and colleagues (1986) found that children with reading disabilities in kindergarten through second-grade had more difficulty with rapid naming of digits and letters than colors and objects, particularly letters.

Rapid naming deficits are independent of and, more persistent (i.e., stable) than phonological awareness deficits. Further, they may indicate a generalized rate of processes deficit that also affects motor processes (e.g., articulation rate) (Fawcett & Nicolson, 1994; Korhonen, 1995; Wolf et al., 1986). However, a rapid naming deficit does not appear to be as robust in older children as in younger children (Fawcett & Nicolson, 1994; Korhonen, 1995), suggesting an influence of maturation or instruction on rapid retrieval. Unlike phonological awareness, research has not established whether rapid naming is amenable to instruction. However, current research indicated that rapid naming is a critical learner characteristic in determining the severity of reading disabilities (Blachman, 1994; Catts, 1993; Felton, 1993).

As currently conceptualized, the difference between phonological awareness and phonological coding\retrieval processes is the difference between specific teachable skills that contribute to an analytical, decontextualized understanding of the sound structure of language, and underlying cognitive processes that may not be amenable to instruction, including rapid naming.

Relation Between Phonological Processing Dimensions and Reading

For the purposes of the dissertation study, reading was divided into two broad processes, word recognition and comprehension (Kahmi & Catts, 1989; Stanovich, 1994). Likewise, phonological processing was divided into two broad categories, the teachable skill of phonological awareness and the cognitive processes of coding and rapid retrieval of coded material. Deficits in phonological processing dimensions directly affect word recognition and indirectly affect comprehension. Specifically, results from phonological processing research indicated that deficits in processing the phonological features of language explain a significant proportion of beginning reading problems and correlated difficulties in reading comprehension, background knowledge, memory, and vocabulary differences (Liberman & Shankweiler, 1985; Lyon, 1995; Mann & Brady, 1988; Rack et al., 1992; Torgesen et al., 1990; Wagner & Torgesen, 1987). The mass of evidence supporting the phonological core deficit theory is sufficiently large enough to be "an established fact" (van Ijzendoorn & Bus, 1994, p. 273).

In a review of scientific advances in reading disability, Lyon and Chhabara (1993) reviewed three lines of research that challenge "a strictly phonological account of reading disability" (p. 4) and provide an extension to the phonological core deficit theory. Those three lines of research comprise investigations of linguistic and visual processes, verbal and nonverbal temporal processing deficits, and a broad language-based deficit. For example, Tallal and colleagues (1996) have been examining temporal processing deficits in language-learning impaired children. Their investigations suggest that the auditory problem of an inability to recognize sounds of short-duration, such as /b/ and /d/, may be the root of language-learning impairment. Tallal and colleagues hypothesize that language-learning deficits may represent "bottom-up processing constraints rather than a defect in linguistic competence per se" (p. 83). Moreover, phonological awareness deficits may share the same root (Barinaga, 1996).

Of significant importance is that the deficit appears amenable to training and can be identified as early as a child's first year. Specifically, with intense training that used computer technology to lengthen sounds of short duration by 50% and to make those sounds louder, children that were behind 1-3 years in speech and language development approached or exceeded normal ranges in speech discrimination and language comprehension (Tallal et al., 1996). As an example of work outside educational contexts, Tallal and colleagues' work portends immense implications for educational interventions for prevention of and remediation of reading disabilities.

Within the phonological core deficit theory, recent research suggested that awareness and retrieval processes (i.e., rapid naming) make large and independent contributions to variance in reading achievement (Catts, 1993; Torgesen et al., 1994). In addition, converging evidence across numerous sources offered unequivocal support that phonological awareness is causally and reciprocally related to reading acquisition. For purposes of the dissertation study, reading acquisition was divided into two phases: (a) early acquisition prior to instruction in letter-sound correspondences and independent use of printed materials, and (b) beginning reading acquisition that involves initial letter-sound and decoding instruction. Current research is investigating which phonological awareness tasks and what size of phonological unit for task performance are instructional priorities for the two phases of reading acquisition. Moreover, two levels of phonological awareness are hypothesized: (a) a minimum level of sensitivity that involves recognition at the level of syllables and onset-rime, and (b) a fully explicit level that involves manipulations at the phoneme level and an analytical understanding (e.g., Stanovich, 1992). Specifically, the fully explicit level of phonological awareness has been established as a causal factor in early reading acquisition; however, a current hypothesis is that phonological sensitivity to larger phonological units and skill in easier tasks of rhyme and alliteration may be sufficient for early reading acquisition (Torgesen & Davis, in press). Thus, what sequence of tasks, what level of phonological awareness, what size of phonological units for task performance,

and what level of proficiency for specific tasks are sufficient for each phase of reading acquisition have not yet been empirically established.

However, the phonological awareness tasks most closely related to reading acquisition are blending and segmenting (Smith et al., 1995; Torgesen et al., 1994). Phonological awareness deficits in those tasks affect word recognition performance and rapid retrieval deficits affect list learning performance, such as learning the alphabet and rapid identification of orthographic patterns (Catts, 1993; Cornwall, 1992; Felton, 1993). Current research is examining the effect of the interrelationships of processing deficits on word recognition.

Emerging evidence suggests that performance on phonological awareness measures and rapid naming can define the extent and severity of risk for reading disabilities (Blachman, 1994; Cornwall, 1992; Felton, 1993). Extent is defined by the number of tests within each task for which performance met deficit criteria. Severity is defined by the presence of more than one deficit (i.e., phonological awareness and retrieval processes or rapid naming). In measuring the two types of deficits in 81 children, Felton (1993) found that the majority of children had phonological awareness deficits in contrast to rapid naming deficits. Moreover, conclusions from a recent longitudinal study indicated that while poor phonemic awareness may create the need for remedial reading services, also having a rapid naming deficit may keep a child in remedial services (Wood, cited in Blachman, 1994). Note that rapid naming deficits have been found more persistent (i.e.,

stable) than phonological awareness deficits (Korhonen, 1995; Torgesen et al., 1994).

Those children who have difficulty identifying the first and last sounds in words, and segmenting and blending word parts at the onset-rime and phoneme levels prior to beginning reading acquisition will experience difficulty in learning to read. Children can improve performance in those skills with explicit instruction and the improved performance will have a positive, facilitative effect on learning to read. However, while rapid naming may not be amenable to instruction as is phonological awareness, the deficit is important to identify early because a child with both awareness and retrieval deficits may require more intense instruction over a longer period. The following section describes the research that is extending Yopp's (1988) work on identifying and understanding specific sources of complexity in phonological awareness tasks.

Effects of Word Features on Phonological Awareness Task Complexity

Knowledge from previous studies in phonological awareness tasks confirms their differential importance to reading. In addition, a series of studies has also examined the effect of linguistic complexity on phonological awareness performance. Linguistic complexity refers to word features that can be represented by gradations in size (Stahl & Murray, 1994) and articulatory features of words such as sounds that can or cannot be elongated. For purposes of the present study, linguistic complexity features will be limited to word length (i.e., number of

phonemes), size of phonological unit (e.g., word, syllable, onset-rime, phoneme), consonant clusters, and the articulatory features of words. Linguistic complexity has been hypothesized to be linked to children's performance on phonological awareness tasks. According to this hypothesis, children may have difficulty accessing and manipulating phonological units because of interactions among: (a) levels of development, (b) range of instructional experiences, and (c) the wide range of complex word features in a specific task. One secondary source (Treiman & Zukowski, 1991), and eight primary studies provide delineation of linguistic complexity features and their interaction with student performance (Bowey & Francis, 1991; Caravolas & Bruck, 1993; Gonzalez & Garcia, 1995; Kirtley et al., 1989; McBride-Chang, 1995; Stahl & Murray, 1994; Treiman, 1985; Treiman & Weatherstone, 1992).

Extension of Yopp's Investigation of Phonological Awareness Task Difficulty

The construct of phonological awareness is defined and measured by multiple tasks such as deleting and segmenting phonemes. To tease out the sources of difficulty that some children experience with those tasks, Stahl and Murray (1994) extended Yopp's (1988) study of the relative difficulties associated across phonological awareness tasks. In a correlational study with 52 kindergarten and 61 first-grade normally achieving children, Stahl and Murray (1994) controlled a source of variability not controlled by Yopp (1988)---linguistic complexity. Phonological measures included blending, phoneme isolation, segmentation, and

deletion. Examples of tasks included saying the first or last sound for phoneme isolation, and removing the beginning or ending of a word and saying the word that is left, (e.g., saying *cat* without /c/). Tests were constructed for each phonological awareness task across four levels of linguistic complexity: onset-rime, vowel-coda within rime, cluster onset, and cluster coda. Test items beginning with continuants alternated with items beginning with stop sounds. For example, a child would be asked to segment words at each level of complexity and to blend, segment, isolate phonemes, and delete at each level with alternating continuant and stop sounds. Thus, scores across phonological awareness tasks for each level and scores across levels for each task were created by the test. Two scores allowed separate analyses for task complexity and levels of linguistic complexity. The 70-item measure was highly reliable.

Stahl and Murray's (1994) analysis of linguistic complexity dimensions was limited to the effects that size of phonological unit and the presence of consonant clusters had on children's performance on manipulation tasks. Confirming findings from other studies (Kirtley et al., 1989; Treiman, 1985; Treiman & Weatherstone, 1992), Stahl and Murray (1994) found that the onset-rime level was the easiest to segment, whereas the most difficult levels were onset clusters (CC in CCVC words) and cluster codas (CC in CVCC words). Onsets are the initial phoneme[s] followed by the rime that consists of the vowel and consonant[s].

Differential Difficulty of the Onset-rime and Phoneme Levels

Four primary studies and one secondary source study suggested additional explanations for the differential difficulty of onset-rime and phoneme level tasks (Bowey & Francis, 1991; Kirtley et al., 1989; Treiman, 1985; Treiman & Zukowski, 1991). Treiman (1985) explained that onset-rime units are more accessible than phonemes because they are cohesive units that function as real psychological units. The studies referenced extant research indicating that syllabic segmentation precedes phonemic segmentation as a "natural developmental phenomenon" (Bowey & Francis, 1991, p. 100). Conversely, Bowey and Francis hypothesized that phonemic segmentation only developed concurrently with or as a result of instruction. In contrast to the Bowey and Francis hypothesis, Kirtley and colleagues (1989) suggested that when the phoneme acts as an onset it can be segmented without instruction. In other words, the difficulty lies not in the phoneme level but in the context in which a specific phoneme exists. Specifically, phonological manipulations are less difficult "when the phoneme [that the children] have to detect represents the whole of a viable speech unit (the onset) but not when it is only part of such a unit (part of a rime)" (p. 233) or part of a cluster. Thus, difficulties associated with accessing the phoneme level appear to hinge on dimensions of linguistic complexity.

Interrelations Among Features of Linguistic Complexity

Likewise, three primary studies (Caravolas & Bruck, 1993; Gonzalez & Garcia, 1995; Treiman & Weatherstone, 1992) found that "linguistic properties of the stimuli affected the children's performance in a systematic manner" (Treiman & Weatherstone, 1992, p. 174). Interestingly, two of the studies (Gonzalez & Garcia, 1995; Treiman & Weatherstone, 1992) replicated a study conducted with Dutch children examining the effect of word length, initial and final clusters, position of stressed syllables in words, and articulatory properties of words (Schreuder & van Bon, cited in Treiman & Weatherstone, 1992). The conclusions of Gonzalez and Garcia (1995) and Treiman and Weatherstone (1992) supported the results from a third study designed to examine whether difficulty in segmenting onsets is universal across languages (Caravolas & Bruck, 1993). The three studies found that complexity in segmentation and phoneme detection is a function of the following features: While shorter words are easier than longer words, the complexity of longer words is often a function of increasing number of clusters and the complexity of clusters (number of phonemes). In addition, clusters in a word add to the complexity, and continuant phonemes are easier to manipulate than stops. Thus, the studies indicated that "[t]he access to phonological units of speech can be mediated by the influence of word linguistic properties" (Gonzalez & Garcia, 1995, p. 194). However, some language-specific effects were found. Comparisons of differential response to linguistic complexity suggested that specific language input affected performance on supposedly difficult features. For example, complex onset

clusters are heard more often in Czech, onset-rime distinctions in English, and multisyllabic words in Spanish. These language specific differences in input appeared to create a familiarity effect that favorably affected performance in cross-language comparisons. This means that children speaking Czech had less difficulty with complex clusters than English-speaking children because complex clusters are a common linguistic unit in their language.

In addition, a fourth study (McBride-Chang, 1995) supported the differential effect that linguistic features of words contribute to complexity. The features manipulated in the study included articulatory features, word length, position, and clusters. Drawing upon the line of research represented by Tallal and colleagues (1996), the McBride-Chang (1995) study was one of few educational studies to examine the relation between speech perception and phonological awareness in English. Findings indicated that manipulating linguistic features had a clear effect on task difficulty. McBride-Chang and Stahl and Murray (1994) concurred in recommending that task difficulty be systematically varied across and within phonological awareness tasks, particularly for young children.

In summary, because "[t]he core deficit responsible for the majority of cases of reading disability is at the most basic level of the language system---the level of the phoneme," (Lyon, 1995, p. 3) it is important to understand dimensions that mediate complexity at the phoneme level. Therefore, knowing that linguistic complexity can mediate the difficulty of a new task has direct instructional design implications for phonological awareness interventions. For example, the difficulty

of a new task could be mediated by using the onset-rime level, selecting short instructional words, not selecting words with clusters, and selecting words that contain continuants in the target positions.

Phonological Interventions for Prereaders Low in Phonological Awareness

Interventions for children low in phonological awareness are reviewed and organized according to: (a) primary studies, (b) comparison of primary studies, (c) secondary sources, and (d) issues and methodologies to be addressed.

Primary Studies

Six phonological awareness intervention studies are reviewed in this section (Brady et al., 1994; O'Connor et al., 1993; O'Connor et al., 1995; Slocum et al., 1993; Torgesen et al., 1992; Torgesen & Davis, in press). Except Slocum et al. (1993), all studies investigated the effect of phonological awareness intervention on reading or letter knowledge. Nevertheless, discussion of effects will be limited to effects on phonological awareness and processing. Studies were selected according to the following criteria:

1. The participant sample targeted only prereaders low in phonological awareness (O'Connor et al., 1995; O'Connor et al., 1993; Torgesen et al., 1992; Torgesen & Davis, in press); or the study targeted socioeconomically disadvantaged children (Brady et al., 1994; Slocum et al., 1993).

2. An experimental design was employed and the published article included data, descriptions of independent and dependent variables, and a discussion of the results.

3. Dependent measures included phonological awareness measures.

4. The intervention was for kindergarten children or prereaders.

5. Included this mixed criteria: instruction in segmentation and blending, was for English-speaking children, and was taught to a group of children in contrast to individual instruction. One exception was included that employed individual instruction because instruction occurred at the onset-rime level for blending and segmenting (Slocum et al., 1993).

Instructional Design Issues

All interventions investigated acquisition of phonological awareness. In addition, the interventions addressed three instructional design issues and will be reviewed accordingly to general focus of investigation. First, is there transfer within and across phonological awareness skills and if so, does learning one skill facilitate learning another skill (O'Connor et al., 1993; Slocum et al., 1993)? An example of across skills is rhyming to blending and within skills is segmenting first sound to segmenting all phonemes in sequence. Second, what is the most parsimonious combination of instructional components (O'Connor et al., 1995; Torgesen et al., 1992; Torgesen, in press)? For example, do children need instruction in an array of skills (e.g., rhyming, blending, segmenting) or are two

skills sufficient? Third, what is the effect of the theoretically-based instructional design feature of scaffolding on phonological awareness and processing (Brady et al., 1994)?

Evidence of transfer. Two studies with preschool children investigated the existence of transfer across classes of skills with and without instruction on the transfer skill (O'Connor et al., 1993; Slocum et al., 1993). For example, does learning to segment increase ability to blend before instruction in blending and does learning to segment positively affect learning to blend? In addition, O'Connor and colleagues (1993) investigated transfer within skill class as well as across skill classes. For example, onset-rime segmentation was examined within the skill class of segmentation.

O'Connor, Jenkins, Leicester, and Slocum (1993). The feasibility of teaching phonological awareness skills to preschoolers with disabilities enrolled in a special education preschool was investigated in an experimental pre-post study in which 47, four- to six-year-old children were randomly assigned to one of four experimental conditions or to a control condition. The instructional conditions were: (a) rhyming, (b) blending, (c) segmenting, and (d) a control condition, the routine classroom preschool activities plus individual instruction in isolated sounds twice during the intervention. Children who scored 30% or more on the rhyming, blending, and segmenting pretests were excluded along with a child with autism.

Dependent measures included: (a) phonological awareness (i.e., rhyme recognition and production, blending onset-rimes and phonemes, segmenting onset-

rimes and phonemes), (b) letter recognition (recognition of names and/or sounds accepted), and (c) The McCarthy Scales of Children's Abilities (McCarthy, 1972, cited in O'Connor et al., 1993). Tests were administered pre-, mid-, and post-intervention.

Common to the experimental conditions was a set of 71 words formed from 12 phonemes representing a range of continuous and stops sounds and scaffolding of task complexity using continuous sounds during the initial phase. In addition, teacher modeling and leading were followed by group responses. During Phase I, the rhyme condition worked on rhyme production, the blending condition on two- and three-phoneme words with stretched sounds (said slowly without stops between sounds), and the segmenting condition on saying two- and three-phoneme words slowly. In Phase II, the rhyme condition reviewed rhyme production and worked on discriminating words that rhyme and do not rhyme, the blending condition worked on blending onset-rimes, and the segmenting condition on segmenting onset-rime, first sound identification, and saying the separate sounds in words. During both phases, children in the control condition engaged in preschool activities such as circle time and story reading. Also, during Phase II in the control condition, the researcher met with each child twice to practice individual sound production.

Findings indicated a reliable difference between the performance of children in treatment and control conditions at posttest on phonological awareness measures. Specifically, children within a skill condition performed significantly higher on the

trained skill than children in other treatment conditions or in the control condition. Within skill groups, generalization to novel items was significantly greater; however, not all children fully generalized to a set of within skill, untaught items. Between groups, little transfer occurred across skill classes (i.e., rhyming training did improve blending). However, there was one notable exception. Children who received segmenting instruction improved from pretest to posttest in blending continuous sounds. Thus, the results suggested that learning segmentation first, may facilitate learning to blend.

O'Connor and colleagues (1993) suggested that lack of transfer may indicate that phonological awareness is not a unitary construct with multiple dimensions, but that skills are more independent and isolated than presently conceptualized. In addition, they suggested that lower generalization scores may also be explained by instructional design features such as insufficient range of examples or insufficiency in other areas of design.

Slocum, O'Connor, and Jenkins (1993). In a pre-post study investigating the effect of learning one phonological awareness skill on the acquisition of a second skill, 35 Head Start preschool children (M age = 5.2 years) were randomly assigned to one of two experimental conditions or one of two control conditions. The instructional conditions were: (a) blending then segmenting, and (b) segmenting then blending; control conditions included: (a) word manipulation then segmenting, and (b) word manipulation then blending. Participants were children who would

enter first-grade the next academic year; students receiving special education services were excluded.

Dependent measures included: (a) phonological awareness (onset-rime segmentation and blending), and (b) verbal ability (PPVT-R). The phonological awareness tests were administered pre-, mid-, and post-intervention.

The onset-rime segmentation condition followed a scaffolded teaching format that included graduated amounts of teacher assistance: (a) an initial assessment with no teacher assistance, (b) teacher model of the skill followed by student performance of the skill, and (c) use of scaffolded materials in modeling and guided practice followed by repetition of the task without scaffolded support (e.g., squares for segmentation and pictures representing the words). The teaching sequence was repeated with sets of words comprising five words each. The onset-rime blending condition followed a similar scaffolded teaching format. The word manipulation condition was similar to the segmentation and blending condition; however, larger units of sound (e.g., words in phrases) were used.

Results indicated that young prereaders with low receptive language skills can learn blending and segmentation with direct instruction; however, there was little indication of transfer across skills. For example, results from midpoint tests and at posttest indicated that performance improved only when test administration in a specific skill was preceded by direct instruction in that skill.

"[T]he strong results from training onset-rime segmentation replicate the near ceiling-level posttest performance found by Fox and Routh (1984) after

teaching the task" (Slocum et al., 1993, p. 626). Differences in the size of the phonological unit to be segmented among Fox and Routh (1984), Slocum et al. (1993), and Torgesen et al. (1992) studies were relevant to the dissertation study. Use of the onset-rime level appeared to mediate the complexity of segmentation (Fox & Routh, 1984; Slocum et al., 1993).

Instructional design issue of parsimony. Identifying the most parsimonious combination of instructional components for optimum effect on the development of phonological awareness and reading acquisition has been a phonological awareness issue for decades (e.g., Fox & Routh, 1984; O'Connor et al., 1995; Torgesen et al., 1992). Blending and segmenting have been established as prerequisites for reading acquisition (Torgesen et al., 1994; Wagner & Torgesen, 1987). Findings from the Fox and Routh (1984) study indicated that segmentation and blending are more efficacious than segmentation alone. Torgesen and colleagues (1992) extended their research by asking the final question in that line of research. Is the combination more efficacious than blending alone? Moreover, is the combination sufficient or does instruction in an array of phonological awareness skills result in more generalized phonological awareness? O'Connor and colleagues (1995) investigated whether instruction in an array of phonological awareness tasks results in a more generalized phonological awareness skill and if the effect on reading is greater than instruction in the combination of segmentation and blending. Thus, both studies investigated the effects of differential components on the development of phonological awareness.

The research questions driving the Torgesen and Davis (in press) study were understanding individual response to instruction and identifying subject characteristics that predicted response to treatment---not instructional design issues. Nevertheless, the study is included in this subsection because Torgesen and Davis's finding contribute to the most parsimonious combination issue.

Torgesen, Morgan, and Davis (1992). In a pre-post study designed to investigate the effects of phonological interventions on phonological development and word reading ability, 48 kindergarten children were randomly assigned to one of two experimental conditions or to a control condition. The instructional conditions were: (a) blending and segmenting, (b) blending, and (c) control, language experience instruction without any phonological awareness instruction.

Participants were children whose scores fell between the 15th and the 50th percentile on a research version of a screening instrument (Test of Phonological Awareness, Torgesen & Bryant, 1994b). In addition, children were eliminated who could read more than one nonword correctly from the Word Analysis subtest from the Woodcock Johnson Reading Mastery Test (Woodcock, 1973, cited in Torgesen et al., 1992). From the children considered for intervention, those who had poor attendance records, serious behavior problems, or attended special classes were excluded.

Dependent measures included: (a) phonological awareness (phoneme blending, phoneme segmentation), (b) alphabetic reading and (c) general verbal

ability. In addition, a reading analogue test was administered post intervention, similar to O'Connor et al. (1995).

Common to the two experimental conditions were seven sets of words that comprised a limited number of phonemes. The sequence for the blending and segmenting condition follows. After several days of warmup activities with familiar tasks (e.g., rhyme), children were taught to identify phonemes in two- and three-phoneme words by position---beginning, ending, middle. Next, they were taught to pronounce each sound in a word and then to blend separated sounds presented to them into a word. In the blending condition, children were taught to identify words represented by sequences of phonemes orally presented to them. Children responded by choosing the correct picture representing the word from two- and three-choice sets of pictures. Then, children were taught to pronounce the word presented as a sequence of phonemes without picture prompts. The control condition included activities that emphasized reading and books as enjoyable and relevant.

As expected, children in the blending-segmenting condition significantly out performed children in the blending only condition on segmentation and blending measures. Children in the blending condition performed clearly better than children in the segmenting-blending condition on only the blending measure. Torgesen et al. (1992) concluded that the lack of transfer from blending condition to untaught segmentation tasks at posttest indicated that teaching only one task did not result in a conceptual understanding of phonological awareness. Specifically, "training in

both types of tasks may lead to a more complete, decontextualized concept of the phonological structure of words than training on a single type of task" (p. 368). Decontextualized means being accessible in new unsupportive, text-based contexts. This conclusion is supported by O'Connor et al., 1995.

Almost one-third of the children in the blending-segmenting condition did not improve from pretest to posttest on the segmentation task. Torgesen et al. (1992) suggested that reversing the order of instruction in future studies (i.e., beginning with instruction in blending rather than segmentation) may decrease the difficulty of learning phonemic segmentation. The Phonological Awareness Training Program for Reading [PATR] (Torgesen & Bryant, 1994a) includes that modification and begins with blending instruction.

O'Connor, Jenkins, and Slocum (1995). In a pre-post study investigating the breadth of phonological awareness instruction necessary to produce levels of phonological awareness and letter-knowledge ability similar to good readers, 66 kindergarten nonreaders, low in phonological awareness skills, were randomly assigned to one of two experimental instruction conditions or to a control condition. The instructional conditions were: (a) auditory blending and segmenting with limited letter-sound correspondences (b) a global array of phonological tasks (e.g., blending, segmenting, and rhyme) with limited letter-sound correspondence, and (c) a control condition, only letter-sound correspondences. A fourth group of 25 randomly selected nonreaders with high phonological awareness skills did not

participate in the three instructional conditions. Their progress in the regular classroom was used as a comparison condition.

Participants were children scoring between 0-30% on pretests (blending and segmenting single syllable words into onset-rime). Non-English speaking students were excluded; however, children identified for, or in the referral process for special education services were included. In addition, children who scored above 50% on the combined pretest scores and were nonreaders (i.e., could not read any of the words from the posttest reading analogue test) were considered for the highly-skilled comparison condition.

Dependent measures included: (a) phonological awareness (blending, segmenting, syllable deletion, rhyme production, first sound in word identification), (b) letter knowledge and reading (rapid letter naming, word identification), and (c) verbal ability (receptive vocabulary [PPVT-R]).

Blending and segmenting instruction began at the onset-rime level for 3 of the 10 weeks followed by instruction at the phoneme level. Materials were used to scaffold complexity by using pictures to reduce memory load, two- and three-square laminated forms that children touched while segmenting to give concrete representation to an auditory activity, and card games for practice. The global condition taught a variety of manipulations (e.g., blending, segmenting, rhyming, word-to-word matching) by scaffolding linguistic complexity. For example, instruction began at the sentence and word level before proceeding to the phoneme level. Similar to the blending-segmenting condition, letter-sound instruction began

in week five and letters were not used during phonological tasks. The control condition received no special instruction except in week five, when letter-sound instruction began.

Results indicated that although both treatment conditions outperformed the control condition, the two treatment conditions did not differ significantly from each other on phonological awareness measures at posttest. O'Connor et al. (1995) concluded that the information from the Lindamood Auditory Conceptualization Test [LAC] (Lindamood & Lindamood, 1979) indicated that the children learned to generalize beyond instruction to new tasks because of the following features of the LAC. The LAC used different stimuli (nonsense words) than used in instruction, a different response format (colored blocks to represent manipulations), and several new tasks (phoneme substitution and addition). Thus, using the LAC scores, O'Connor et al. (1995) inferred that the children "attained phonological insight broader than the combination of skills taught in their respective treatments and that blending and segmenting were sufficient to produce this result" (p. 213).

O'Connor et al. (1995) indicated that indications of transfer in LAC scores is in contrast to findings from prior research (Fox & Routh, 1984; O'Connor et al., 1993; Slocum et al., 1993; Torgesen et al., 1992) that have shown little if any transfer from learning one phonological skill to another skill. Instruction brought low-skilled children up to the level of high-skilled, but untreated children. However, because high-skilled children continued to grow in these skills without

explicit instruction, the inference was that low-skilled children, in contrast to high-skilled children need explicit instruction to progress.

In short, findings indicate the parsimonious combination of blending and segmenting is as effective as a more varied approach. However, although teaching fewer skills (i.e., blending and segmenting) may appear more efficient, as both conditions performed similarly, lower levels of generalization to novel words for the blend-segment condition than the global condition may indicate need for further attention to "improving the quality of instructional tasks or length of training" (O'Connor et al., 1995, p. 214).

Percentage of participants that remained low-skilled after instruction was less than 20%. However, the 20% is qualified by the following data. Of the 18 children that remained low-skilled, 15 were in the control, 2 in the blend-segment, and 1 in the global condition.

Torgesen and Davis (in press). In a pre-post study examining individual differences in response to a 12-week phonological awareness intervention, 60 kindergarten children were randomly assigned to a phonological awareness condition, and 40 children were randomly assigned to a control condition. Children who scored below the 80th percentile on a short phonological awareness measure (Test of Phonological Awareness [TOPA], Torgesen & Bryant, 1994b) were randomly assigned to either the treatment or the control condition.

Dependent measures included: (a) phonological awareness, (b) phonological processing (i.e., memory and naming rate), (c) letter knowledge and beginning

reading and spelling, and (d) general verbal ability. Individual growth curves were estimated with pre-, mid-, and posttest blending and segmenting scores.

In the phonological awareness condition, children were taught to blend, detect phonemes by position in a word (first sound, last sound, middle sound), segment, and pronounce all the phonemes in a given word. Instruction in these skills was repeated across a series of five word sets. During the last weeks of instruction, children were taught a limited number of letter-sound correspondences to blend the letter-sound correspondences into words, and to spell. In the control condition, children did not receive any special instruction. They participated in the whole language instruction in the general education classroom.

Results indicated substantial overall training effects for the phonological awareness intervention. Invented spelling and general verbal ability pretest scores best predicted segmentation performance, whereas invented spelling and rapid automatic naming of digits best predicted blending performance. The predictor variables for blending accounted for essentially all of the variance in blending performance. This is in contrast to the predictor variables for segmentation that accounted for a modest proportion of segmentation performance. Differences in predictor variables for the two skills lends support to the current conceptualization of blending and segmenting as correlated, but separate skills (Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993, cited in Torgesen & Davis, in press). The results also support a current conceptualization of the reciprocal relation between alphabetic knowledge and phonemic awareness (Bowey & Francis, 1991). That is,

those children with high pretest scores in invented spelling (a sensitive measure for alphabetic understanding) scored significantly higher on posttest measures of phonological awareness and letter-knowledge than those children with low scores for invented spelling at pretest.

Although some children made impressive gains in performance, substantial numbers of children did not experience significantly improved performance, similar to other studies (e.g., Torgesen et al., 1992).

Instructional design issue of effects of scaffolding. A specific focus on the effects of highly scaffolded and theoretically-based instructional design features was particularly relevant to the dissertation study. The Brady et al. (1994) study is unique in its reported overarching reliance upon a theoretical framework to drive instructional design.

Brady, Fowler, Stone, and Winbury (1994). In a pre-post study evaluating a phonological awareness training program, four intact, inner-city kindergarten classes (n=96) from low socioeconomic communities were used. Two classes were assigned to the experimental condition and two classes to the control condition. The instructional conditions were: (a) instruction in precursor skills to phonemic segmentation (i.e., rhyming; segmentation of sentences, phrases, and words into progressively smaller units; categorization; finding syllables in different positions, isolating the phoneme, and analyzing internal syllabic structures), and (b) the control condition, a whole language curriculum in an unmonitored regular classroom setting.

Unlike the other five studies, Brady et al. (1994) used intact classrooms. However, the authors selected classes with the least number of bilingual children to avoid problems of accurate assessment of bilingual children with measures "specific to English phonology" (p. 40). All students received instruction; however students were eliminated from the data analysis who were bilingual, who could read at least one word on the Word Identification subtest from the Woodcock Johnson Reading Mastery Tests-Revised (Woodcock, 1986, cited in Brady et al., 1994), and for other reasons such as severe speech problems and children whose posttest PPVT-R scores were below an IQ equivalent of 80.

Dependent measures included: (a) phonological awareness (rhyme production, phoneme segmentation, and phoneme deletion), (b) letter, word, spelling, and math knowledge and achievement, (c) cognitive and verbal ability measures (receptive vocabulary, nonverbal concept formation), and (d) phonological processing (memory for word strings, perception, speech production, rapid naming). In addition, during first-grade the following measures were used: (a) promotion to first-grade, and (b) decoding (i.e., the Woodcock Identification and Attack subtest (Woodcock, 1986, cited in Brady et al., 1994).

The intervention had three phases focusing on: (a) phonological awareness at the sentence, word, and syllable level, (b) isolation of the phoneme, and (c) detection of the internal structure of syllables. Activities for Phase I (awareness above the level of the phoneme) included rhyming, segmenting, categorizing, and identifying phonological units. Activities in Phase II (isolating the phoneme)

focused on articulation, relying heavily on the Auditory Discrimination in Depth Program [ADD] (Lindamood & Lindamood, 1979). Phase III (internal structure) was based on Ball and Blachman's (1991) "say it and move it" procedure that uses markers to represent sounds (Brady et al., 1994).

The comparability of the conditions on pretest scores was particularly important because Brady and colleagues (1994) did not use random assignment. In the fall, the two conditions had slight differences on phonological processing, phonological awareness, and cognitive ability. Moreover, the scores indicated that nearly all the children were nonreaders and low in phonological awareness.

Children in the training condition performed significantly better than the control on rhyme and better on the segmentation and deletion tests at posttest. The results supported Brady et al.'s (1994) hypothesis that training would also improve basic phonological processing (e.g., memory, speech production, and rapid naming) in that the training condition performed significantly better on the speech production measure. For the speech production measure, children were asked to quickly and accurately repeat multi-syllable nonwords for 10-12 repetitions.

Brady et al. (1994) did not include information about numbers of students who did not progress. However, significant differences were achieved on only one of three phonological awareness measures (rhyme) though the training program resulted in increases in phonemic deletion and segmentation. Limitations of the study included an insensitive scoring system for phonemic segmentation---correct or

incorrect, which did not reflect the scaffolded progression from large to small units in the intervention.

Comparison of Experimental Studies

In this section, the six experimental interventions are compared according to the following features: (a) participant characteristics, (b) independent variables, (c) dependent measures, (d) measurement procedures, (e) treatment characteristics and fidelity of implementation procedures, and (f) effects of phonological awareness instruction.

Participants

Four of the studies intervened with kindergarten children (Brady et al., 1994; O'Connor et al., 1995; Torgesen & Davis, in press; Torgesen et al., 1992) and two with preschool children (O'Connor et al., 1993; Slocum et al., 1993). Four of the studies focused on children low in phonological awareness (O'Connor et al., 1993; O'Connor et al., 1995; Torgesen & Davis, in press; Torgesen et al., 1992) and two on disadvantaged children (Brady et al., 1994; Slocum et al., 1993) who were also found to have low skills but were not chosen based on low skills. All the studies worked with children in general education settings, except O'Connor et al. (1993). Participants attending special classes were excluded from the Torgesen et al. (1992) and Slocum et al. (1993) studies, whereas O'Connor and colleagues (1993) worked with children with various developmental delays enrolled in a special education

preschool. Specifically, significant language delays characterized 80% of those children. The children represented the largest age range of any group of participants (4-6).

Independent Variable

In this section, the independent variables across six intervention studies are analyzed according to: (a) major components, (b) size of phonological unit, and (c) sequence of instruction for components.

Primary components. Phonological awareness components included, segmentation, blending, rhyme, and an array of tasks that included first sound identity and deletion. The combination of blending and segmenting was taught in three kindergarten studies (O'Connor et al., 1995; Torgesen & Davis, in press; Torgesen et al., 1992); while those same skills were taught separately in two preschool studies (O'Connor et al., 1993; Slocum et al., 1993). Segmentation and a global array of other skills, but no blending, were taught in one study (Brady et al., 1994). Moreover, rhyme was included in the global array condition in two studies (Brady et al., 1994; O'Connor et al., 1995), as a warmup activity in two studies (Torgesen & Davis, in press; Torgesen et al., 1992), and as a separate instructional condition in one preschool study (O'Connor et al., 1993). Letter-sound correspondences were taught in two studies (O'Connor et al., 1995; Torgesen & Davis, in press). All studies included segmentation and blending.

Size of the phonological unit. Size of the phonological unit included compound words, syllables, onset-rimes, and phonemes. Four of the six interventions used the onset-rime format to teach segmentation (Brady et al., 1994; O'Connor et al., 1993; O'Connor et al., 1995; Slocum et al., 1993). In addition, two studies taught segmentation at a larger phonological unit than onset-rime (e.g., compound words) (Brady et al., 1994; Slocum et al., 1993). Except for two studies (O'Connor et al., 1993; Slocum et al., 1993), onset-rime was used as a short, intermediate step before teaching segmentation at the phoneme level. Instruction did not proceed beyond the onset-rime level in the Slocum et al. (1993) study with Head Start children, and segmentation at the onset-rime level was taught after the phoneme level in the O'Connor et al. (1993) study with preschoolers with disabilities. Brady and colleagues (1994) based their intervention on the theory that larger phonological units (e.g., words, syllable, onset-rimes) are more accessible to prereaders than the phoneme unit. Consequently, the intervention taught segmentation at the larger levels before progressing to the most difficult level, the phoneme. However, the study was not designed to compare the theoretically-based progression of instruction from large to small units.

Sequence of component instruction. Research has been examining the optimum sequence for teaching blending and segmenting for several decades. One study extended earlier research and examined the final comparison, blending and segmenting compared to blending only (Torgesen et al., 1992), while other studies examined the following current questions. What phonological awareness tasks are

sufficient for a positive effect on reading? Does learning one task help learning a subsequent task? Is there transfer of learning across tasks?

Torgesen et al. (1992) examined whether it was more effective to teach both segmenting and blending or a single skill (i.e., blending) for maximal effect on reading acquisition. In so doing, the study extended the work of Fox and Routh (1984) that indicated the combination is better than segmentation alone. The O'Connor et al. (1995) study compared a blending and segmenting condition to a global array of phonological awareness skills condition; whereas a global condition was compared to a control condition in Brady et al. (1994). Two studies compared the instructional sequence of blending and segmenting to examine evidence of transfer (i.e., effect of prior learning of skill A on learning skill B) (O'Connor et al., 1993; Slocum, 1993). In the O'Connor et al. (1993) study, students were only taught one skill but posttested on all skills; whereas, in the Slocum et al. (1993) study, students were taught segmenting and blending in different sequences (i.e., blending then segmenting, and segmenting then blending).

Dependent Measures

In this section, dependent measures are analyzed according to type and the sensitivity of measures to complexity in segmentation tasks.

Types of measures. The six studies administered measures in five areas of language development to assess the effects of instructional condition: (a) phonological awareness, (b) letter knowledge, (c) reading, (d) verbal ability, and (e)

phonological processing. Phonological awareness and either verbal or cognitive ability measures were employed in all studies. Although phonological processing is highly related in current theoretical explanations of reading disabilities (e.g., Blachman, 1994; Torgesen et al., 1994), a battery of phonological processing measures was employed in only two studies (Brady et al., 1994; Torgesen & Davis, in press). A single phonological processing measure, rapid letter-naming, was used in another study (O'Connor et al., 1995). Letter knowledge measures were employed in four studies (Brady et al., 1994); O'Connor et al., 1993; O'Connor et al., 1995; Torgesen & Davis, in press) and reading measures in four studies (Brady et al., 1994; O'Connor et al., 1995; Torgesen & Davis, in press; Torgesen et al., 1992).

Sensitivity and complexity. Given that segmentation is more difficult than blending, the following compares features according to sensitivity and complexity: (a) length of words, (b) size of unit to be segmented, (c) number of additional measures related to segmentation, and (d) presence of consonant clusters in test items.

In the dependent measures of auditory segmentation, the number of words ranged from 10 to 24. The length of words (2-3 phonemes) was similar for three studies (Brady et al., 1994; O'Connor et al., 1993; Slocum et al., 1993). The wider range (2-5 phonemes) in Torgesen et al. (1992) reflected a graduation of complexity for test items. Gradations included a higher ceiling of complexity in length and phonological features (e.g., use of phoneme clusters such as /st/). Two studies used

both the onset-rime and phoneme levels (O'Connor et al., 1993; O'Connor et al., 1995), two used only the phoneme level (Brady et al., 1994; Torgesen et al., 1992), and one study used only the onset-rime level (Slocum et al., 1993). The Torgesen et al. (1992) study used only the most difficult level (phoneme) and a higher ceiling for length.

The size of unit (e.g. compound word) and number of units (e.g., first sound only) to be segmented varied across specific segmentation measures. Related tests were used to more fully examine possible precursors to segmentation. For example, a syllable deletion task was included because it is an easier phonological task than deletion or segmentation of phonemes. "Examiners state a word (baseball) and ask the child to say the word minus one syllable (Say it again, but don't say base)" (O'Connor et al., 1995, p. 205).

The task complexity of segmentation is increased if test items include phoneme clusters. Phoneme clusters are particularly difficult for young English-speaking children (Treiman, 1985). Only one study used clusters (Torgesen et al., 1992). Clusters were in 7 of 15 test items. Moreover, two of the seven cluster words had two clusters within a single word (e.g., ground, craft) and a three-phoneme cluster in splash. In addition, although the test scaffolded difficulty of items (e.g., the first four words were two-phoneme words and the last three were the multiple cluster and multiple phoneme cluster words), size of the phonological unit was not scaffolded. Moreover. 50% of the test items contained complex items.

Measurement procedures. Specific measurement procedures can isolate response to treatment. For example, formative procedures provide information about: (a) rate of learning, and (b) differential response to intervention phases. Therefore, using summative and formative procedures facilitates examination of both achievement and learning (Fuchs, 1989; Fuchs, Fuchs, Hamlett, Walz, & Germann, 1993; Tindal & Marston, 1990). All studies used summative procedures with traditional pre-post test administrations to assess achievement. Only one study, (Brady et al., 1994) used a delayed posttest; however the instruments measured transfer to reading skills in the following year (i.e., first grade) and not maintenance of learned behavior. Thus, none of the studies used measures that would give information about the durability of the target intervention skills.

Efficiency was examined with two procedures, number of errors to proficiency and rate of learning. For example, efficiency was determined by number of errors to criterion on phonological awareness in Slocum et al. (1993), on letter-sounds and word-learning (efficiency of transfer effects) in Torgesen et al. (1992), and on the effect of previous learning on learning of a second skill in Slocum et al. (1993) and O'Connor et al. (1993). Three studies used pre-, mid-, and posttest periods of assessment (O'Connor et al., 1993; Slocum et al., 1993; Torgesen & Davis, in press) to examine differential response to treatment phase. However, only the Torgesen and Davis (in press) study used those three data points to estimate individual growth curves. None of the six studies used curriculum-based progress monitoring to estimate rate of growth.

Treatment Characteristics and Fidelity of Implementation Procedures

Treatment characteristics and fidelity of implementation are important to answer the following questions. Were similar effects achieved with similar resources? Were treatments delivered according to criteria and were the effects the result of instructional design and not extraneous variables?

Resources and feasibility. The six intervention studies had the following similarities in resources. Except for the 18-week study by Brady and colleagues (1994), the average length was 9 weeks, and the average duration for all studies was 15 minutes. With the exception of the Slocum et al. (1993) study, the average frequency was 3 times per week and the average group size was 3-5 children. Average total instructional time was 11 hours. The Torgesen and Davis (in press) and the Brady et al. (1994) studies had the largest total instructional time. Note that the 12-week Torgesen and Davis (in press) study achieved equivalent total time to the 18-week Brady et al. (1994) intervention by maximizing frequency and duration of sessions.

The length of teacher training ranged from four to eight hours. Three studies reported fidelity of implementation procedures (Brady et al., 1994; O'Connor et al., 1993; O'Connor et al., 1995) and two studies reported controlling for teacher effects (O'Connor et al., 1995; Slocum et al., 1993). See Table 1 for further comparisons among studies.

TABLE 1. Intervention Resources

Study/ Total Instructional Time	Length	Duration	Frequency	Group Size
O'Connor, Jenkins, & Slocum (1955) 5 hours	10 Weeks	15 Minutes	2 x Week	3-5 Children
O'Connor, Jenkins, Leicester, & Slocum (1993) 4 hours 40 minutes	7 Weeks	10 Minutes	4 x Week	3-5 Children
Torgesen, Morgan, & Davis (1992) 8 hours	7-8 Weeks	20 Minutes	3 x Week	3-5 Children
Torgesen & Davis (in press) 18 hours	12 Weeks	20 Minutes	4 x Week	3-4 Children
Brady, Fowler, Stone, & Winbury (1994) 18 hours	18 Weeks	20 Minutes	3 x Week	Intact Class
Slocum, O'Connor, & Jenkins (1993) 1 hour 40 minutes	10 Sessions	10 Minutes	N/A	Individual

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Effects of Treatment

This section will address the following: (a) effects on phonological awareness and processing, and (b) percentage of children who did not respond to instruction. The discussion will be limited to effects on two phonological awareness skills, segmenting and blending, and phonological processing.

Effects on phonological awareness and processing. Effects of interventions were reported in terms of growth in task performance, effects of combining segmentation and blending, transfer, effects across a range of cognitive and language abilities, and phonological processing.

All studies reported significantly greater effects of treatment than control conditions on phonological awareness measures. Results of instruction in the combination of blending and segmenting were comparable to instruction in an array of phonological awareness skills and significantly better than blending in isolation (O'Connor et al., 1995; Torgesen et al., 1992). Specifically, using the combination of blending and segmenting may have resulted in a broader insight or a "more complete decontextualized concept" (Torgesen et al., 1992, p. 368). The Torgesen et al. (1992) and the O'Connor et al. (1995) studies employed concurrent instruction of blending and segmenting, unlike the O'Connor et al. (1993) and the Slocum et al. (1993) studies.

Little transfer from learning one skill to learning a second skill was found, except segmentation (O'Connor et al., 1993; Slocum et al., 1993). However, O'Connor and colleagues (1995) suggested that successful performance on a posttest

measure [LAC] to untaught tasks and new response formats indicated that instruction in phonological awareness resulted in a broader and more generalized level of skill. This is in partial contrast to O'Connor et al. (1993) and Slocum et al. (1993) studies that found little evidence of transfer across skills (that learning one skill first facilitated learning another skill).

Instruction resulted in improved performance across a range of cognitive and verbal ability within low-skilled children and across a narrow age range (i.e., 4-6). Therefore, it is feasible to teach phonological awareness to children with low language skills, specifically children with disabilities receiving special education services. Most important, children receiving special education were able to attain a phonological awareness level comparable to that of more skilled peers with instruction (O'Connor et al., 1995), and cognitive ability did not limit learning (O'Connor et al., 1993). Brady et al. (1994) was the single study to measure changes in a battery of phonological processes after intervention. The training condition improved speech production significantly more than the control condition.

Participants who did not progress. Lack of progress is indicated by static performance from pretest to posttest. Comparison of the numbers of students who did not progress in segmentation and blending in spite of instruction is limited by the lack of comparable data across studies. For example, several studies reported the percentage of students who did not progress, whereas other studies presented the information in graphs or used such phrases as "substantial numbers of children in kindergarten indicated very little growth in. . . ." (Torgesen & Davis, in press, p.

14). In addition, O'Connor and colleagues (1995) included control data in their report of children who did not progress (20%), in contrast to Torgesen and colleagues (1992) who reported 30% for treatment conditions.

Analysis of measures indicated that clusters were in 50% of the test items in two studies reporting substantial numbers of children who did not progress (Torgesen & Davis, in press; Torgesen et al., 1992). Findings from research (e.g., Fowler, 1991; Treiman, 1985) have indicated that young children and children with phonological awareness deficits have difficulty with segmenting clusters. Although the measure was designed to measure fully explicit phonemic awareness, such a stringent test may not provide sufficient information about the development of segmentation ability.

In addition, visual inspection of graphs in the Slocum et al. (1993) and O'Connor et al. (1993) studies indicated the following: Two of nine children were at floor for the segmentation posttest in the "segment then blend" condition (Slocum, 1993). In the O'Connor et al. (1993) study with preschoolers with developmental delays, very few floor or near floor effects were seen except in the segmentation condition. Visual inspection of graphs indicated that 6 of 11 children did not progress on the first sound identity. Last, in the Brady et al. (1994) study, only 6 of 21 children were able to correctly segment by phoneme in the spring. Brady and colleagues suggested that a dichotomous scoring system was insensitive to segmentation ability at the onset-rime level and did not give partial credit which

could have indicated differential ability by position of phoneme and size of phonological unit.

All studies indicated that while some children made significant improvement, a substantial number did not progress. Moreover, segmentation was the more difficult task. Explanations for lack of progress included the possibility of an insufficient range of examples, low performance on predictor variables such as invented spelling and rapid naming, and insensitive measures. As a result, several authors suggested the need for future intervention research to examine dimensions of sufficient intensity in instructional variables for all students to make progress (e.g., Torgesen et al., 1994).

Secondary Sources

The following section describes two kindergarten studies (Blachman, Ball, & Tangel, cited in Blachman, 1994; Torgesen et al., 1994), and summarizes instructional implications from prior research (Blachman, 1991; Catts, 1991; Jenkins & Bowen, 1994; Lundberg, 1995; Schuele & van Kleek, 1987; Smith et al., 1995). Findings are described in terms of the relation between the characteristics of students who may experience difficulties with reading acquisition and their instructional needs.

Kindergarten Studies

In a two-year study, Blachman, Ball, and Tangel (cited in Blachman, 1994) worked with kindergarten children in low socioeconomic inner-city schools. They examined the effects of a kindergarten phonological awareness intervention and a first-grade reading intervention on reading achievement at the end of first grade. In an 11-week kindergarten intervention, students were taught phoneme segmentation, letter-sound, and letter-name instruction in 41, 15-20 minute sessions. At the end of kindergarten, children in the experimental condition performed significantly higher than children in the control condition on phoneme segmentation, letter-sounds and names, decoding regular words and nonwords, and spelling measures.

At the beginning of first grade, Blachman and colleagues (cited in Blachman, 1994) grouped the children by phonological awareness ability. Then, children with persistent low scores on the kindergarten measures received an additional 12 weeks of small-group instruction. They were taught phoneme segmentation, letter naming and sounds, and reading and spelling by word families. At the end of first-grade, children in the experimental condition performed significantly higher on phonological awareness, letter-sound, reading, and spelling measures and fewer were retained in first-grade than children in the basal condition. Because the intervention was longer it could be more intense (Blachman, 1991). "Perhaps the most important point is that as length and complexity of treatment increased (i.e., as we continued to foster skills in phonological awareness,

alphabetic coding, and automaticity), we also had fewer 'treatment resisters'" (p. 289).

In a 12-week kindergarten study, segmentation, blending, and letter-sound correspondences were taught in 20-minute sessions four times a week to groups of three to four children (Torgesen et al., 1994). On segmenting and blending performance, approximately 70% of the children in the control condition scored lower than children in the treatment condition. The effect sizes for segmentation and blending were 1.35 and 1.84 standard deviation units, respectively. However, there was much variability in response to instruction. For example, 30% of the children receiving experimental instruction did not progress. Performance on two pretests, invented spelling and rapid naming of digits, predicted those same children who did not progress. Therefore, it is assumed that the children who need instruction in phonological awareness because of low scores in phonological awareness and letter knowledge will also have difficulty with instruction in phonological awareness.

Summary of Instructional Implications From Prior Research

Extant research denotes several important implications regarding the design and delivery of phonological awareness instruction and illuminates knowledge gaps (Wagner, 1993) in which research-based evidence is lacking. First, timing of instruction is critical. Strong convergence supports the critical importance of early

identification and early intervention in preschool and kindergarten before the cycle of failure begins (Blachman, 1994; Catts, 1991).

Components and optimum sequence. Research across multiple disciplines has indicated that phoneme identity, segmentation, and blending are important components of phonological awareness interventions (Blachman, 1991, 1994; Catts, 1991; Jenkins & Bowen, 1994; Schuele & van Kleek, 1987; Smith, et al., 1995; Torgesen & Barker, 1995). The optimum sequence for those components has not been established empirically (Smith et al., 1995). However, an examination of language development literature and the relative importance of specific components to reading acquisition suggested the following.

Instruction in phoneme identity (isolation of a specific phoneme within a word), segmentation, and blending are necessary but not sufficient components for kindergarten students prior to formal reading instruction (Blachman, 1991, 1994; Catts, 1991; Jenkins & Bowen, 1994; Schuele & van Kleek, 1987; Smith et al., 1995). Moreover, segmentation and phoneme identity are important prerequisites to more difficult phonological awareness skills. That is, the more difficult phonological awareness tasks such as deleting, adding, substituting, or reversing phonemes require children to first segment or isolate phonemes or larger units such as syllables before manipulation (e.g., deletion) (Catts, 1991).

Allocation of time. Findings from the research literature indicated that the average intervention was nine weeks, with 15-20 minute sessions conducted four times a week during the kindergarten year (Smith et al., 1995). Similarly, the

average for kindergarten interventions was a 15-minute session conducted three times a week for 11 weeks for a total of 7.6 hours of instruction (Smith, in preparation). Findings from a meta-analysis indicated that the mean total instruction was nine hours (Wagner, Torgesen, & Rashottte, cited in Torgesen & Barker, 1995).

Instructional design. Despite strong support for the underlying instructional priority of phonological awareness, procedural details for designing phonological awareness interventions are often lacking (Smith et al., 1995). The following is a summary of phonological awareness research support for one of the instructional design principles articulated by Dixon, Carnine, and Kameenui (1992)---mediated scaffolding. Forms of mediated scaffolding were employed in every intervention, and thus received the strongest empirical support (Smith et al., 1995).

Mediated scaffolding is the external support provided by the teacher, tasks, and materials during initial learning. The amount and type of mediated scaffolding is determined by the needs of individual students in relation to the task. While the support can take the form of task adjustment, materials variations, or teacher support, task adjustment was most widely employed in the studies reviewed as reflected in the following discussion.

Task adjustments are made by attending to complexity. Specifically, attention to the size of the phonological unit decreases the complexity of task dimensions difficult for learners with low phonological awareness (Blachman, 1991; Catts, 1991; Jenkins & Bowen, 1994; Smith et al., 1995). For example, the

complexity of more difficult tasks (e.g., segmentation) can be scaffolded by attending to the size of the sound unit and the phonological features of the unit (Blachman, 1991; Catts, 1991; Jenkins & Bowen, 1994; Schuele & van Kleek, 1987). Larger sound units such as syllables and onset-rimes are more accessible because they are "more discrete" (Catts, 1991, p. 198). Catts indicated that "because of the abstractness of phonemes, very explicit and lengthy training is usually necessary for children to learn to divide words into phonemes" (p. 198). Moreover, there is "strong evidence to suggest that the concept of speech-sound segmentation may be facilitated by beginning instruction at the syllabic level" (p. 198).

Thus, use of design principles facilitated perception of, quality of representation and, therefore, retrieval of phonologically coded material (Smith et al., 1995). This conclusion is particularly significant for children with phonological deficits, who have difficulty becoming aware of the abstract, phonological features of words to which we do not consciously attend (Adams, 1990a).

Issues and Methodologies to Be Addressed

Three research literatures have been reviewed---phonological awareness and processing, word features that contribute to phonological awareness task complexity, and phonological awareness interventions for prereaders low in phonological awareness. All the recent research provided support for the phonological core deficit theory of reading disabilities. However, findings from

intervention research indicated that some children failed to progress in phonological awareness performance despite phonological awareness instruction. The review of recent task complexity research suggested specific features of words that may contribute to their static performance.

The dissertation study targeted prereaders who may not progress without more strategically designed interventions than those presently employed in research.

Therefore, selection of issues and methodologies to be addressed was guided by the purpose of understanding response to instruction and those instructional variables that may mediate performance and focused on three issues.

Can Prereaders Profit From Instruction at the Phoneme Level Prior to Letter-Sound Instruction?

First, recent conceptualizations suggested a two-level hierarchical development of phonological awareness: (a) a holistic sensitivity to phonological structures that involves recognition of alliteration and rhyme, and (b) a fully explicit analytical awareness that includes ability to manipulate at the phoneme level (Bowey, 1994; Bowey & Francis, 1991; Stanovich, 1994; Torgesen & Davis, in press). The dissertation study addressed the issue by examining two interventions designed to develop the ability of prereaders to segment and blend at the phoneme level.

Phonemic awareness appears dependent upon concurrent acquisition of alphabetic understanding (Bowey, 1994; Bowey & Francis, 1991; Kirtley et al.,

1989; Stanovich, 1994). Thus, the issue is: Is phonological awareness at the phoneme level dependent upon letter knowledge or can the difficulty of the phoneme level be mediated by instructional variables before letter knowledge acquisition? However, the relations among instructional variables, development, and within child deficits are not fully delineated by current research (Slocum et al., 1993). The dissertation study examined these relations by selecting prereaders low in phonological awareness and maximizing the effect of instructional variables with a strategically designed intervention.

Can Instructional Design Features Mediate Complexity at the Phoneme Level?

Second, Slocum and colleagues (1993) suggested the need for research that examines features that contribute to complexity in phoneme segmentation. Will teaching the onset-rime level before the phoneme level mediate complexity, compared to teaching the phoneme level directly? In addition, scaffolding articulatory features of words may mediate task complexity. For example, scaffolding involves using words that begin with continuants at the time of initial instruction in new tasks and leaving clusters until tasks are familiar and partially mastered (Caravolas & Bruck, 1993; Gonzalez & Garcia, 1995; McBride-Chang, 1995; Stahl & Murray, 1994; Treiman, 1985; Treiman & Weatherstone, 1992). The following features of the dissertation study addressed scaffolding complexity. Common to both treatment conditions was use of continuants during the introduction of new tasks. The effect of using onset-rime level will be compared to

using the phoneme level across the two treatment conditions. In addition, across the two experimental interventions, the curriculum was modified by attending to instructional design features that increase the explicitness, or intensity of instruction.

Can Attention to Limitations of Measures and Measurement Methodologies Increase Our Understanding of Response to Instruction?

Third, measures used in prior research may have limited our understanding of children's progress during phonological awareness interventions. Specifically, attention to the following limitations of measure selection, scoring system, phonologic complexity of test items, and procedures in the studies reviewed may increase explanatory power of response to instruction. Although rapid naming is highly related in current theoretical explanation of reading disabilities (e.g., Blachman, 1994; Torgesen et al., 1994), rapid naming measures were employed in only three studies (Brady et al., 1994; O'Connor et al., 1995; Torgesen & Davis, in press). Floor effects at pretest in segmentation were reported in many studies (e.g., O'Connor et al., 1993; Slocum et al., 1993). Floor effects suggest insensitivity of a specific test to earlier precursors to segmentation. Use of additional measures to tap precursor skills may increase sensitivity of measures to individual differences. Brady and colleagues (1994) said that a dichotomous scoring system (correct or incorrect) was not sensitive to the highly scaffolded progression from larger to smaller units in the intervention. Half the segmentation test items represented high levels of phonologic complexity (i.e., clusters) in a study that employed one

segmentation measure and reported that the performance of 30% of the children remained static (Torgesen et al., 1992). Although the test was designed to measure phonemic awareness at the fully explicit level, perhaps additional measures with less stringent proportion of complex test items would indicate additional information about segmentation development. The dissertation study employed rapid naming measures and multiple measures to be used in analyses to follow the dissertation that will examine individual response to segmentation instruction. The sensitivity of measures used in the dissertation study is indicated by the following features: partial credit, first and last sound recognition as well as sequential phonemic segmentation measures, isolated and within syllable phoneme manipulations, and graduated difficulty of items on the blending test.

Specific measurement procedures can explain response to treatment. None of the studies used measurement procedures that would give information about the durability of the intervention's target skills. Only one study estimated rate of growth (Torgesen & Davis, in press). The dissertation study employed both delayed posttest and weekly progress monitoring to estimate rate of growth.

CHAPTER III

METHOD

This chapter describes the methods used to address the research questions and includes: (a) setting, (b) participant selection, (c) independent variable, (d) dependent variables, (e) procedures, (f) design and data analyses, and (g) summary. The research questions addressed whether it is more efficient and effective to teach onset-rime segmentation as a precursor to teaching phonemic segmentation than to teach phonemic segmentation directly.

Setting

The study took place in three elementary schools in a suburban school district, serving a total student population of approximately 10,700. Of this number, 1,300 students received special education services. School A had three kindergarten classes, each with approximately 27 children. School B had four kindergarten classes, each with approximately 22 children. The schools each served more than 50 students in special education, and each provided Title I services. School C had four kindergarten classes each with approximately 23 children, did not provide Title I services, and provided 59 children with special education services. The school district is located in a Pacific Northwest town with a population base of approximately 45,000. Schools A and B are in low-to-moderate

socioeconomic neighborhoods; whereas, School C is in a moderate socioeconomic neighborhood. Schools A and B served as experimental and equivalent control conditions whereas School C served as a non-equivalent control condition. A non-equivalent control condition was used to control for potential instructional effects in the other two schools.

Design and Participant Selection

Kindergarten children from three schools in a suburban school district in Northwestern Oregon were considered for participation by following human subjects procedures and by administering screening measures.

Screening Procedures

First, consent and permission to participate were obtained from the participants' parents or guardians before any observations, training, or data collection. Standard practices for conducting research with human subjects were employed by following the school district and University of Oregon guidelines and regulations.

Test of Phonological Awareness [TOPA]

In December, children in eight kindergarten classrooms (n = 201) were screened using the Test of Phonological Awareness [TOPA] (Torgesen & Bryant, 1994b) to identify possible participants. After administration of the screening

measure, one teacher withdrew from the project because of philosophical differences with the screening measure reducing the number of possible participants to 181 children. Children whose scores fell at or below the 32nd percentile on the TOPA were considered for participation. Based on national norming results, Torgesen and Bryant (1994b) recommended that kindergarten children scoring at or below the 25th percentile during the second half of kindergarten were considered to have significant phonological awareness delays that would adversely affect reading and spelling acquisition. The present study used the 32nd percentile because the 25th percentile did not exist for a first-semester kindergarten test administration. Moreover, one point in the total raw score differentiates the 19th and the 32nd percentiles. Of students in the seven classrooms (n = 181), 74 were considered for participation based on (a) a score at or below the 32nd percentile on the TOPA, (b) parent permission, and (c) lack of health problems that would prevent regular attendance during the intervention. Approximately 40% of the total kindergarten children in the eight classrooms across three schools were identified by the screening measure [TOPA] as delayed in phonological awareness; whereas, across the two schools which represented equivalent-control and experimental conditions only, approximately 53% of the children were identified by the screening measure compared to 30% in the third school representing the non-equivalent-control condition.

Nonsense Word Reading Fluency Subtest
of DIBELS [NWF]

After the TOPA screening, the Nonsense Word Reading Fluency Subtest from the Dynamic Indicators of Early Basic Literacy Skills battery [DIBELS] (Good et al., 1992b) was administered to identify children who could read more than one nonword correctly (Davidson & Jenkins, 1994; Torgesen et al., 1992). A nonsense word is a phonetically regular made-up word (e.g., dosh). The test was given because a reciprocal relation has been documented to exist between phonological awareness and reading (Smith et al., 1995). This means that just as phonological awareness facilitates acquisition of alphabetic knowledge, so does alphabetic knowledge facilitate acquisition of phonological awareness. For this reason, children who knew some letter-sound correspondences and were able to use that letter-sound knowledge to decode words would have an advantage over children without letter-sound correspondence or decoding knowledge. Students who could read more than one nonword correctly were not considered for participation in the project. None of the children could read one or more nonsense words correctly.

Group Assignment

Within each classroom, screening scores [TOPA] were used to stratify children into high (32nd percentile), middle (12th-19th percentile), and low (2nd-7th percentile) performance groups. In the two equivalent-control schools, children

from each of the TOPA performance groups were randomly assigned to one of three instructional conditions within their own classroom: (a) one of two experimental conditions, or (b) the equivalent-control condition. Children in the non-equivalent control condition were not randomly assigned.

Following stratification and random assignment, 85 informed consent letters were sent home with participants. The overall response rate was high (94%), and highest in the non-equivalent control school (100%). See Table 2 for participant assignment to condition.

TABLE 2. Number of Children in Instructional Conditions

	School A	School B	School C	Total
WAP	11	10		21
WORP	12	11		23
Equivalent Control	10	6		16
Non-Equivalent Control			14	14
Total	33	27	14	74

Subject Attrition

During the course of the study, 5 of the 74 participants (6.8%) were discontinued from the study at various phases: (a) 1 from WAP, (b) 3 from WORP, (c) 1 from equivalent-control, and (d) none from the non-equivalent control. Four children moved and one child was too disruptive to be taught in a

group setting. At the request of the parent, the child continued to receive the intervention one-on-one with the interventionist but was not considered in the group analyses.

Participant Characteristics

Seventy-one children in eight kindergarten classrooms participated in the study through posttest and 69 through delayed posttest. Forty-one (59.4%) participants were male and 28 (40.6%) were female. No significant differences were found between groups for attendance, F (3, 65) = 1.54, $p > .05$, for age, F(3, 65) = .65, $p > .05$, or gender, chi-square (4, n = 69) = 2.06, p >.05. Table 3 summarizes the participant demographics, including age, gender, and attendance data for children who completed the delayed posttest phase.

The children attended half-day kindergarten (i.e., 2.5 hours per day). Children in experimental conditions left the classroom for 15-minutes of instruction delivered by an interventionist hired by the investigator. Setting varied across and within schools. In School A, children were taught in the music room in the morning and in an empty kindergarten room in the afternoon. In School B, children were taught in a small storage area adjacent to the rest rooms in the morning and afternoon. Two interventionists taught four morning groups in each school, and two different interventionists taught two afternoon groups in each school. Each interventionist taught both instructional conditions.

TABLE 3. Demographics of Children By Instructional Condition

	WAP	WORP	Equivalent Control	Non-Equivalent Control	Total
Gender					
Male	11	10	10	10	41
Female	9	10	5	4	28
Mean Age (in months)	70.60	70.80	70.47	69.00	70.30
SD	4.48	4.38	3.20	3.37	3.96
Age Range (in months)	61-80	64-78	65-75	65-75	61-80
Mean Attendance (per 31 days)	26.95	27.45	28.33	29.00	27.81
SD	2.61	4.11	2.77	1.41	3.03
Range of Attendance (in days)	22-30	15-31	22-31	27-31	15-31

Children in School A received instruction at the same time, Monday through Thursday. At the request of the classroom teachers, children in School B received instruction at a different time every day during the activity period. Approximately 33% of all children in the experimental conditions received other special services, such as speech, language, and a volunteer reading-aloud program out of the regular classroom. The combination of a short instructional day, special services pull-out, intervention pull-out, and weekly progress monitoring meant that frequently children would miss preferred activities in the regular classroom. All children in

the non-equivalent control condition remained in the regular classroom without receiving any special intervention other than those for children identified for special education services.

Independent Variable

Despite the documented importance of phonological awareness to reading acquisition, scant evidence exists regarding the instructional design to promote its efficient and effective acquisition and retention. The present research used three instructional conditions as the independent variable: (a) two phonological awareness interventions (word and phoneme [WAP], word-onset-rime-phoneme [WORP]), and (b) instruction in the regular classroom as equivalent- and non-equivalent control conditions. The experimental interventions were conducted for 9 weeks, 4 days per week, in 15 minute sessions.

The following section describes: (a) the commercially published program which was the basis of the two experimental conditions, (b) identical modifications of the commercial program common to both experimental conditions, (c) different modifications for the experimental conditions, and (d) the control conditions.

Basis of Curricula: A Commercially Published Program

The curricula for the WAP and WORP conditions were modifications of the Phonological Awareness Training for Reading [PATR] program by Torgesen and Bryant (1994a). The three-phase program was chosen on the basis of research-

documented dimensions, current use in intervention research, commercial availability, and gradation of phonological awareness task difficulty. Five features of the original program [PATR] important for students low in phonological awareness include: (a) the introduction of a limited number of new phonemes in any given lesson (n = 3), (b) daily practice across a range of examples (i.e., 8 wordsets), (c) cumulative review with games, (d) emphasis on the articulatory features of phonemes, and (e) materials support with pictures to represent words, colored squares to represent auditory manipulation, and games to motivate practice activities. Following is a brief description of the three phases of the unmodified program [PATR].

Description of Original PATR

In the warm-up phase, children are taught to identify words that rhyme and to produce words that rhyme. Torgesen and Bryant (1994a) indicated that rhyme is used for the warm-up phase because it is an easy phonological awareness skill that many children may have acquired prior to the intervention. In the second phase, blending, identifying and comparing phonemes in specific positions (first, last, middle), and segmenting are taught with a series of wordsets (n = 5) comprising a limited number of phonemes (n = 15). Three phonemes are introduced in each wordset. Each set contains approximately 20 words. The wordsets provide practice with phonemes new to the specific wordset and with previously learned phonemes

from prior wordsets across the skills of phoneme identification, blending, and segmenting.

During the second phase, children are first taught to blend onset-rimes and phonemes and then to compare words on the basis of specific sounds (phoneme identification) in the first, last, and middle positions. For example, after isolating and practicing the first sound in man by emphasizing the articulatory features of /m/, children are asked which of three words, represented by pictures, begins with the same sound as man. Children respond by pointing to the corresponding picture. These initial tasks represent easier phonological awareness tasks, whereas the next group of skills are progressively more difficult. Next, children are taught to pronounce phonemes in specific positions and finally, to pronounce all individual phonemes in whole words (i.e., presented as unsegmented words).

The following materials are used to scaffold the complexity of the tasks: (a) words are represented by pictures, and (b) sounds in various positions are represented by a series of squares. For the word bat, the teacher might point to the middle square and ask, "This square stands for /____/?" The child would respond by saying, "/a/." The teacher then says, "This is /a/ because /a/ is the middle sound in bat." (Torgesen & Bryant, 1994a, p. 19). This format was repeated for all positions of phonemes in words and across five wordsets to provide practice in the processes with new phonemes.

In the third phase, comprised of three wordsets, children are taught letter-sound correspondences for a small group of previously introduced phonemes (n =

10) and four vowels. Letter-sound correspondences are introduced at the rate of five new letters per wordset. Finally, the children are taught to use previously learned oral segmenting and blending skills to read real words.

Modifications Common to Both Experimental Conditions

Three modifications were made to the program. Two modifications were identical across both conditions, WAP and WORP: (a) eliminating Phase III letter-sound correspondence, reading, and spelling instruction, and (b) adding instructional design enhancements across phases.

The first modification, eliminating letter-sound correspondence, reading, and spelling instruction, was done to allow additional time for instructional design modifications, and to isolate the effects of auditory training only. The second modification, adding instructional design enhancements, was done to increase the intensity or explicitness of instruction for students with learning disabilities (Blachman, 1994; Torgesen et al., 1994).

The following are examples of instructional design enhancements.

1. Distribute phoneme identity across weeks in contrast to the concurrent presentation in the original program. That is, introduce identification of last and middle positions in separate weeks from week six through week eight.

2. Add a sequential instructional format for segmentation. Explicitly teach phonemes said in sequential order (teacher model and lead). For example, "The sounds in man are /m/, /a/, /n/."

3. Add a review sequence (2-3 examples) at the beginning of each lesson.

4. Add explicit teacher language to make connections between each day's instruction and the previous day.

5. Use consistent terminology (e.g., first sound rather than using multiple terms such as initial sound and beginning sound).

6. Add discrimination sets for previously learned phonemes.

7. Include more group responses before individual testing.

Instructional Formats Common Across Experimental Conditions

The curriculum included seven instructional formats from the Torgesen and Bryant (1994a) program [PATR]: (a) introduction of new wordsets, (b) blending words, (c) blending words with colored squares, (d) articulation training on new phonemes, (e) matching words by sound in a specific position (i.e., first, last, middle), (f) identifying the position of phonemes, and (g) pronouncing phonemes in a given position. The formats were repeated across wordsets, phonemes, and position of phonemes. Modification to the original program [PATR] included two additional formats, sequential segmentation and "say it and move it" (Ball & Blachman (1991). Although segmenting as an auditory activity is a critical preskill for reading acquisition, segmenting sequentially (i.e., saying all the phonemes of a word in sequential order) was not included in the PATR. Rather, only the following three formats were used to teach segmenting in the original program:

(a) identifying phonemes by position (e.g., teacher says the middle sound in a word and the students point to the corresponding square in a three-square template), (b) matching words by common phonemes in a specific position (e.g., the teacher says first sound in cat is /c/, and students point to a picture with the same first sound as /c/ in cat) , and (c) pronouncing phonemes by position (e.g., say the last sound in cat). Ball and Blachman's "say it and move it procedure" was included to meet two purposes, concrete representation of segmenting, and concrete representation of first, middle, and last sounds. Appendix A includes an example of a format added to PATR, sequential segmentation.

Differences Between Experimental Conditions

The third modification affected the size of the phonological unit during weeks 2-6: (a) instruction at the phoneme level for the WAP condition, and (b) instruction at the onset-rime level for the WORP condition. The modification was designed to answer the research question: For students low in phonological awareness, will phonological awareness instruction that proceeds from the onset-rime to the phoneme level be more efficient and effective than instruction at the phoneme level only?

Thus, the WAP and WORP conditions differed on a single dimension---size of phonological unit for segmentation and blending. Both conditions employed the phoneme level exclusively for segmenting and blending activities during the third and final phase. In summary, the single difference between the two interventions

was the size of the unit used for segmentation and blending during weeks two through six, or five of the nine weeks of intervention. Table 4 illustrates the similarities and differences in size of the phonological unit used for segmenting across weeks of instruction.

TABLE 4. Sequence for Size of Phonological Unit in Instruction

Phase	WAP	WORP
Phase I WAP and WORP are the same	Dog and log both rhyme. The sounds are alike at the end. Dog and log end with -og.	Same
Phase II WAP and WORP are different	The first sound in mmaat and mmoomm is /m/. The last sound in mat is /t/.	The first sound in m-at and m-om is /m/. The last sounds in m-at are /-at/.
Phase III WAP and WORP are the same	The last sound in mat is /t/. The middle sound in mat is /a/.	Same

Materials For Experimental Conditions

Materials included scripts for three lessons to be taught over four days each week. Two to four phonological awareness exercises comprised each lesson, including a short review of skills from the previous day. Twenty-six lessons were prepared for the nine-week intervention. Words were represented by individual pictures and by picture-choice sheets. Blending and segmenting exercises were scaffolded with colored squares and two- and three-square templates. In addition,

children used colored markers with the templates for the "say it and move it" exercise adapted from Ball and Blachman's (1991) intervention. Game boards and a Rocky the Robot poster from the PATR program (Torgesen & Bryant, 1994a) were used along with additional game boards created by the teachers were also used. Materials for a behavior management system were identical across teachers and groups which included bears and stickers for appropriate classroom behaviors.

Control Conditions [EC and NEC]

The equivalent [EC] and non-equivalent control conditions [NEC] maintained traditional instruction as occurring in the classroom and received no special intervention. Two control groups were used for bases of comparison in interpreting the effects of intervention: (a) a control group which comprised one of the three conditions for random assignment in two of the three schools, and (b) a non-equivalent control group that was used to control for potential philosophical or instructional effects in the other two schools.

All control classrooms followed a similar schedule: (a) introductory activities that included academic instruction, (b) pull-out time for library, PE, and in school C, music, (c) recess, and (d) approximately one-hour activity period. Children in school B missed only the activity period because of the intervention. In contrast, instructional groups in school A were conducted throughout the morning. The following describes differences that occurred during the one-hour activity period. In school B, equivalent-control teachers conducted play activities designed

to enrich children's experiential base. For example, often children explored different textures and changes of materials in activities centering around food preparation. In school A, equivalent-control teachers also conducted play activities; however, the focus shifted during the intervention to preparation for first-grade academic skills (e.g., writing activities). In the non-equivalent control school, the activity period was structured with large and small-group activities focusing on academic skill development (e.g., writing books) and using play activities for change-up activities.

Dependent Variables

Overview and Rationale

Multiple measures were administered to assess the effects of instructional condition on participants in three areas of language development: (a) phonological awareness, (b) phonological retrieval rate, and (c) alphabetic knowledge. In addition, a verbal ability measure was used at pretest only as an indicator of group comparability on verbal intelligence and to provide information for individual profiles. Measures were administered at screening, pretest, progress monitoring, immediate posttest, and delayed posttest periods. In this section, the rationale for each type of measure is presented and selection criteria and measures are described. Measures are organized by research question.

Phonological Awareness

Based on prior research that suggested that segmenting and blending were the phonological awareness skills most high correlated with reading acquisition, a relatively narrow range of phonological awareness skills were taught and assessed (O'Connor et al., 1995; Wagner, 1988; Wagner & Torgesen, 1987). Instructional and assessment tasks were blending and segmenting at the onset-rime and phoneme levels, and identifying phonemes in target positions, whereas deleting, adding, shifting, and counting phonemes were only assessment tasks. Four reliable and valid instruments, measuring multiple dimensions of segmentation, were used to evaluate the differential effects of all three conditions on the efficiency and efficacy of segmenting growth: (a) the Lindamood Auditory Conceptualization Test-Revised [LAC] (Lindamood & Lindamood, 1979); (b) the Test of Phonological Awareness [TOPA] (Torgesen & Bryant, 1994b); and (c and d) Phonemic Segmentation and Onset Recognition Subtests from the Dynamic Indicators of Basic Early Literacy Skills [DIBELS] (Good et al., 1992b). In addition, the Blending Subtest [CTRRPP] (Torgesen & Wagner, 1995) was used to measure blending at the onset-rime and phoneme levels.

Phonological Retrieval Rate

Rapid naming, a dimension of phonological processing representing retrieval rate for familiar, phonologically coded information, measures rapid pronunciation of items presented visually. It is a significant predictor of reading achievement that

appears to be independent of phonological awareness (Felton & Wood, 1989; Torgesen et al., 1994). Leading phonological awareness researchers (e.g., Blachman, 1994; Brady et al., 1994; J. K. Torgesen, personal communication, August 22, 1995) strongly recommend including rapid naming measures to advance understanding of the relation between phonological processes and students' responsiveness to instruction. Two rapid naming measures were used, The Rapid Color Naming Subtest [CTRRPP] (Torgesen & Wagner, 1995) and Letter-Naming Fluency Subtest [DIBELS] (Good et al., 1992b).

Alphabetic Knowledge

A current issue in phonological awareness research is whether phonemic awareness (i.e., fully explicit phonological awareness) can develop prior to learning letter-sound correspondences or whether alphabetic knowledge is necessary to facilitate the development of phonemic awareness (Bentin, 1993; Bowey & Francis, 1991; Mann, 1993; Torgesen & Davis, in press). In a current conceptualization of phonological awareness, phonological sensitivity (e.g., recognizing rhyme and alliteration) is differentiated from fully explicit awareness at the phoneme level (e.g., phonemic segmenting and blending) (Stanovich, cited in Torgesen & Davis, in press). Phonemic awareness includes segmenting and blending, two skills highly correlated with reading acquisition (Torgesen et al., 1994; Wagner & Torgesen, 1987). Therefore, accurate assessment of letter-sound knowledge is critical in evaluating individual response to a phonological awareness intervention designed to

facilitate acquisition of a "fully explicit level of phonological awareness" (Torgesen & Davis, in press, p. 18) at the phoneme level in the absence of letter-sound correspondence instruction. Consequently, the study examined rapid naming of letters and sounds.

Similarly, a nonword decoding measure was used to exclude children who were already able to decode and as a posttest measure. Because decoding ability appears to have positive effects on phonological awareness growth, specifically phonemic awareness, effects of the intervention would be confounded by children's ability to apply previously acquired alphabetic knowledge (Bentin, 1993; Bowey & Francis, 1991; Torgesen & Davis, in press).

Verbal Ability

Converging empirical evidence has supported the notion that phonological awareness is relatively independent of general intelligence (Smith et al., 1995). However, a recent study (Torgesen et al., 1994) indicated that phonological awareness may not be as independent of general intelligence as has been previously suggested. Many intervention studies use a verbal ability measure as a specific measure of cognitive ability to understand how cognitive and linguistic profiles of participants may help explain response to instruction (Brady et al., 1994; O'Connor et al., 1995). The Peabody Picture Vocabulary Test-Revised [PPVT-R] (Dunn & Dunn, 1981) is frequently used in intervention studies and, therefore, provided a

basis of comparison with other intervention studies with an estimation of verbal ability.

Selection Criteria

The described instruments were chosen on the basis of: (a) technical adequacy (i.e., reliability and validity), (b) common use in research, (c) variety of response modes, (d) combination of fluency and accuracy measures, (e) dimension of segmentation and blending at onset-rime and phoneme level, (f) combination of static and dynamic indicators, (g) combination of local and national norming references, (h) age appropriateness, (i) ease of use (i.e., time for administration and scoring), and (j) standardization. Following, each measure is described according to these features. A schedule of administration for each measure is provided in Appendix B.

Phonological Awareness Measures

The Test of Phonological Awareness [TOPA] (Torgesen & Bryant, 1994b) measures the ability to isolate and compare beginning phonemes in words. The examiner asks children to match pictures with the same beginning sound, or to identify a picture with a different beginning sound than the other pictures. After comparing the pictures, children draw a line through the correct picture. Twenty test items are included in the test comprised of pictures of words with beginning sounds that are the same and different. The TOPA is a published norm-referenced

test with strong technical adequacy. For example, the test/retest reliability is 0.94, internal consistency reliability coefficient is 0.90, and the standard error of measurement is 4.7. Scores from the TOPA were used in screening, stratifying children for random assignment to instructional condition, and as an immediate posttest. The kindergarten version was administered to whole classes with adult monitors to help every three to four children. Administration time was approximately 30 minutes.

The Lindamood Auditory Conceptualization Test-Revised [LAC] (Lindamood & Lindamood, 1979) measures the ability to detect samenesses and differences of sound in two categories, single phonemes and groups of phonemes in syllables. Examiners pronounce sound patterns (e.g., two sounds that are the same), then the student represents the pattern with colored blocks. For example, if the examiner said, "/m/, /m/," the student would place two blocks of the same color side by side.

Scores are reported for the two categories and as a total test score. The total test score was used for data analyses. A commercially published test, the manual supplies norming references for interpretation of the scores. The LAC has high, stable technical adequacy with a test-retest reliability of .96 and predictive validity of 0.73 using the Wide Range Achievement Test [WRAT] combined Reading and Spelling subtest scores. The measure was individually administered as pre- and immediate posttests, taking about 15 minutes. The LAC forms, A and B,

were counterbalanced across times of administration (pre- and immediate post-intervention).

The Phonemic Segmentation Subtest of Dynamic Indicators of Basic Early Literacy Skills [DIBELS] (Good et al., 1992b) measures the fluency of oral segmentation of words. It has multiple probes for monitoring progress frequently during an intervention (e.g., weekly). After the examiner pronounces a word, children orally segment the word. For example, if the examiner said fish, the child would say /f/ /i/ /sh/. Each form of the test has 10 items with a range of 2-4 phonemes per word, or approximately 28 phonemes per form. Results are reported in correct number of segments per minute. Credit is given for each phoneme segmented correctly, capturing responses at the onset-rime and phoneme levels. The test is not published commercially; however, it is easily available and has local school and district norms. In addition, it has strong test-retest reliability, 0.88 for a single probe, 0.98 for the average of daily probes, and 0.78 for rate of progress. Criterion validity is indicated by correlations of 0.73 with the Metropolitan Readiness Test and 0.69 with the McCarthy General Cognitive Index for kindergarten children (Good & Kaminski, 1991). The test was individually administered as a progress-monitoring measure during intervention once a week for ten weeks, as an immediate posttest, and as a delayed posttest taking one minute per administration.

The Onset Recognition Subtest of Dynamic Indicators of Basic Early Literacy Skills [DIBELS] (Good et al., 1992b) measures fluency of onset (i.e., first

sound of a word) recognition and production and has multiple probes for monitoring progress throughout an intervention. Pictures are presented to children as stimuli for onset recognition and production. Students point to the picture that matches the onset pronounced by the examiner and pronounce the onset corresponding to the picture labeled by the examiner. The following is an example of an onset-recognition task. After the examiner labels pictures of a sink, cat, gloves, and hat, the examiner asks the child which picture begins with /s/? The child can either point to the picture of a sink or say the word sink. Cumulative latency of response time per set of pictures is recorded, and the score is reported in number of correct onsets per minute. The test is easily available with local school district norming references. The test-retest reliability coefficient is .70. The test was individually administered as a progress monitoring measure during intervention once a week for 10 weeks, as an immediate posttest, and as a delayed posttest and took approximately one minute per administration.

The Blending Subtest from the Comprehensive Test of Reading Related Phonological Processes [CTRRPP] (Torgesen & Wagner, 1995) measures the ability to blend orally presented word parts into a whole word. After a word is pronounced in segmented format, children are asked to pronounce the word that results when those sounds are blended. For example, the examiner would ask the child what word do these sounds make, /can/ /dy/. The child would respond, candy. The 29-item test includes 2- to 4-phoneme and 1- and 2-syllable words. Credit is given for each word correctly blended, no partial credit is given. The test

is a subtest in a test battery being developed for commercial publication. The internal consistency reliability for this subtest is .88. The test was individually administered as pre-, immediate, and delayed posttest measures, taking about two minutes per administration.

Phonological Retrieval Rate

The Rapid Color Naming Subtest [RCNF] (CTRRPP) (Torgesen & Wagner, 1995) measures the speed with which a child names familiar colors. Prior to testing, children name six colors presented on a card. During testing, colors are named as rapidly as possible from a card with 36 items containing the six colors randomly repeated. The test is being developed for commercial publication and is easily available from the developers. The reliability is .94, although type of reliability was not specified. The test was individually administered as a pre- and immediate posttest measure, taking about two minutes per administration.

The Letter-Naming Fluency Subtest of DIBELS [LNF] (Good et al., 1992b) measures the ability to name letter-names rapidly. A series of lower and upper case letters arranged in random order on a sheet of paper are presented to the child. The child names the letters as rapidly as possible. The scores are reported as the number of correct letter-names per minute. Local school district norm references are available. The test-retest reliability for the rapid letter-naming measure is 0.93 for a single probe, 0.98 for an average of probes, and 0.54 for rate of progress. Multiple forms are available for frequent testing and were used across weekly

administration. The subtest was individually administered as pre-and posttest measures, taking one minute for each subtest.

Alphabetic Knowledge

The Letter Sound Fluency Subtest of DIBELS [LSF] (Good et al., 1992b) measures the ability to name letter-sound correspondences rapidly. Letters representing sounds are arranged in random order on a sheet of paper and presented to the child. The child then pronounces the sounds as rapidly as possible for one minute. The scores are reported as the number of letter sounds correctly stated per minute. The subtest was individually administered as pre-and posttest measures, taking one minute for each subtest.

The Nonsense Word Fluency Subtest [NWF] [DIBELS] (Good et al., 1992b) measures the ability to decode nonsense words (e.g., rall). Accuracy and fluency are measured across a range of high incidence, high-utility sounds and sound combinations. After being given standardized directions and practice opportunities, students are asked to read a word or as much of a word as they can. The subtest comprises five columns of eight words each. Credit is given for each phoneme read correctly. Students are given 60 seconds to read the words. The test is a research measure that is in development. The test was individually administered as a screening and as a pre/posttest measure and takes about one minute to administer.

Verbal Ability

The Peabody Picture Vocabulary Test-Revised [PPVT-R] (Dunn & Dunn, 1981) measures receptive vocabulary. Series of pages, each with four drawings, are shown to the child, and the child is asked to point to the drawing that corresponds most closely to the word pronounced by the examiner. Testing stops after children incorrectly identify six of eight consecutive items. The PPVT-R is a commercially published norm-referenced test with retest and alternate form reliability scores ranging from .77 to .82. It was individually administered as a pretest, taking about 10 minutes. Standard scores were used to examine group comparability prior to intervention on an estimation of verbal ability.

Data Collection

Data was collected during five periods of the study: (a) screening, (b) pre-intervention, (c) formative progress monitoring on student performance and fidelity of treatment data during the intervention, (d) immediate post-intervention, and (e) delayed-post. Fourteen children from a third school served as a non-equivalent control condition, receiving only a subset of the full complement of pre- and immediate posttests. Immediate posttests were administered at the end of the week the intervention was completed and delayed posttest, four weeks post intervention. The progress monitoring measures were administered once a week for 10 weeks to assess growth on two indicators of phonological awareness, Phonemic Segmentation Fluency and Onset Recognition Fluency [DIBELS].

Relation of Measures to Research Questions

The study used a combination of formative and summative techniques to address two research questions.

1. Is there a statistically significant difference in the efficacy of the phonological awareness experimental and control conditions as measured by:

(a) pre/immediate post performance on Phonemic Segmentation and Onset Recognition Subtests [DIBELS] (1992), Lindamood Auditory Conceptualization Test-Revised [LAC] (1979), Test of Phonological Awareness [TOPA] (1994), and Blending Subtest [CTRRPP] (1995)?

(b) pre/delayed posttest performance on Phonemic Segmentation and Onset Recognition subtests [DIBELS] (1992) and Blending subtest [CTRRPP] (1995)?

(c) pre/immediate posttest performance on Letter-Sound Naming Fluency, and Nonsense Word Fluency Subtests [DIBELS] (1992)?

(d) pre/immediate posttest performance on Rapid Color Naming Subtest [CTRRPP] (1995) and Letter-Naming Fluency Subtest [DIBELS] (1992)?

2. Is there a statistically significant difference in the efficiency of the experimental and control conditions as measured by:

(a) number of weeks to proficiency on the Phonemic Segmentation Fluency Subtest [DIBELS] (1992)?

(b) rate of growth as measured by the slope of performance on the Phonemic Segmentation Fluency and Onset Recognition Subtests [DIBELS] (1992)?

Proficiency was determined by the average level of phonemic segmentation for kindergarten children within the local area, or 35-45 segments per minute (Good & Kaminski, 1991; Koehler, 1996).

Fidelity of Treatment

Fidelity of implementation is important to understand the source of effects. Two observers collected fidelity of treatment measures 16 times during the intervention to assess the quality of implementation among the experimental instructional conditions. The 16 observations represented approximately 15% of the lessons taught. Observations occurred during the full instructional period of 15 minutes, across both experimental conditions (i.e., WAP and WORP) for each teacher, and across representative weeks for phases II and III. Phase I represented a warm-up phase lasting for one of the nine weeks of intervention; therefore, it was not included in assessing fidelity of implementation. In addition, the investigator used the checklist weekly as the format for feedback and additional data-collection. See Appendix D for the Fidelity of Implementation Checklist.

Coding

The checklist was based on critical features of the phonological awareness intervention and consisted of 13 items. For example, nine items addressed fidelity of implementation and four items addressed comparability of opportunities to respond and mastery of phonological awareness skills. Each item represented a discrete, mutually exclusive, observable behavior and was scored as observed or not observed. The following critical features of the intervention were coded to assess fidelity: (a) review, (b) model for new, or unmastered skills, (c) lead, (d) group responses, (e) individual responses, (f) error correction, (g) instruction in target skills for the day, (h) correct phoneme and onset-rime pronunciation during phase two, and (i) use of behavior management system. Items on the checklist were scored as present or not present. The total score for each observation (i.e., number of items checked as present) was used to compute the percentage score. The percentage score represented the number of items present divided by the number of possible items.

Additional items were coded to assess comparability of opportunities to respond and to compare levels of mastery on phonological awareness skills. Space was provided to list the number of, and specific words that were in error for group and individual responses. Number of correct responses at the group and individual level were averaged over the 16 observations and divided by the average number of opportunities to respond at the group and individual level of response. This

calculation provided an estimated degree of mastery at the group and individual level of response.

At the completion of the intervention, regular classroom teachers prioritized a listing of emergent literacy activities. A sample of the checklist is provided in Appendix C. The checklist was used to gain a sense of classroom teachers' differential emphases on skills related to early literacy. Emphasis was defined as the rank ordering of activities by the teachers.

Procedures

Training

The following sections describes training for interventionists, data collectors, and fidelity of implementation observers.

Interventionists

Before the intervention began, four interventionists were prepared to use the lesson plans, pictures, colored squares, and games in three training sessions for a total of four hours. The training was conducted by one of the developers of the modified lessons who had taught the lessons in a Fall, 1995 pilot, first-grade phonological awareness study. The intervention is based on an exact sequence of tasks, error-correction formats, conspicuous strategies, and scaffolded tasks, materials, and teacher assistance. Scope and sequence of the lessons and activity formats were explained and modeled in training. Then, the interventionists

practiced lesson formats. After two weeks of teaching, interventionists returned for an additional 1.5 hours of training with the investigator. In addition, every week the investigator observed each interventionist teaching each condition and discussed fidelity of implementation data with the teacher at the end of the observation. These weekly observations were in addition to the 16 fidelity of implementation observations. Moreover, the data from these weekly observations was not included in the fidelity of implementation analysis.

All the interventionists had experience working with young children. Two interventionists were graduate students in special education, one recently received her Ph.D. in School Psychology with an emphasis on early literacy acquisition, and one had volunteer experience teaching and administrating work with large groups of young children. Each teacher taught both conditions; however, each teacher taught at only one school.

Data Collectors

Similarly, before the intervention implementation, seven data collectors were trained with demonstrations and practice of test administration and scoring. Two weeks after data collection began, an eighth data collector was trained. The data collectors included five undergraduate students, one graduate student and two of the experimental teachers. All had preparation and/or experience working with young children. All training and supervising was conducted by the investigator. The training occurred in two, 2-hour sessions. Data collectors practiced administering

and scoring the tests until reaching a range of 90%-100% administration and scoring accuracy on all measures. During the first phase of test administration, administration and scoring was checked approximately twice a week by the investigator.

Reliability of scoring, calculated for each measure, was determined by number of agreements divided by the total number of agreements plus disagreements. In addition, during each phase of data collection, 100% of the scoring was checked by the investigator for reliability and 20% was checked by a graduate student in the School Psychology program experienced in scoring and administering all the measures with the exception of the Peabody Picture Vocabulary Test-Revised [PPVT-R]. The investigator trained the graduate student in scoring the PPVT-R and the graduate student practiced until 100% reliability was achieved. Table 5 indicates the overall reliability for each phase and the range of reliability for individual measures was high.

TABLE 5. Overall and Range of Scoring Reliability for Each Phase of Testing

Phase	Overall Reliability	Range of Reliability
Screening	99%	98.6% - 100%
Pretesting	97%	91% - 100%
Immediate Posttesting	98%	93.3% - 100%
Delayed Posttesting	100%	100%
Progress Monitoring	98.9%	95% - 100%

Observers. Two observers practiced using the Fidelity of Implementation Checklist until they reached 90-100% interobserver reliability during practice sessions. An overall reliability of 94% to 100% was achieved on 10 of the 13 items. A range of interobserver reliability of 92-96% indicated that the observers were reliable with the checklist.

Implementation

After screening and stratification by TOPA scores, students in the equivalent-control schools were randomly assigned to one of three instructional conditions within their own classroom. Weekly progress monitoring began after screening and concurrent with administration of pretest measures and intervention implementation. The intervention was conducted for nine weeks. Children were taught in groups of three-to-four children with six instructional groups per condition. Four interventionists taught the experimental conditions in 15-minute sessions, four times a week. To minimize teacher effects, each experimental teacher taught each condition. Regular classroom teachers taught the control condition.

Design and Data Analysis

Design

An experimental, randomized-block design was used to examine the effects of the independent variable (i.e., phonological awareness instruction varied by size

of phonological unit) on the phonological awareness growth of prereaders with a phonological awareness deficit or delay. The between-subjects factor was instructional group with four levels: (a) WAP, instruction at the phoneme level, (b) WORP, instruction at the onset-rime level before instruction at the phoneme level, (c) EC, equivalent control, and (d) NEC, non-equivalent control. The within-subjects repeated factor was time of test with three levels: (a) pretest, (b) posttest, and (c) delayed posttest. In addition, formative data were used to assess rate of change beyond that typical of pre/post designs.

Data Analysis

Analyses included descriptive and inferential statistics to (a) compare group demographics, (b) answer efficacy and efficiency of instructional conditions, and (c) assess fidelity of treatment. The first research question is:

Question 1: Is there a statistically significant difference in the efficacy of phonological awareness conditions as measured by:

(a) pre/immediate posttest performance on Phonemic Segmentation Fluency and Onset Recognition Fluency Subtests [DIBELS] (1992), Lindamood Auditory Conceptualization Test- Revised [LAC] (1979), Test of Phonological Awareness [TOPA] (1994), and Blending Subtest [CTRRPP] (1995)?

(b) pre/immediate posttest performance on Letter-Sound Naming Fluency and Nonsense-Word Reading Fluency Subtest [DIBELS] (1992)?

(c) pre/immediate posttest performance on Rapid Color Naming Subtest [CTRRPP] (1995) and Letter-Naming Fluency Subtest [DIBELS] (1992)?

(d) pre/delayed posttest performance on Phonemic Segmentation and Onset Recognition subtests [DIBELS] (1992) and Blending subtest [CTRRPP] (1995)?

Because the non-equivalent control group did not receive the full complement of tests, separate analyses of variance were conducted on all measures to examine potential group differences at pretest. Although no significant differences between groups were found, a composite of pretest scores was created for each group of measures (a) specific measures of phonological awareness, (b) general measures of phonological awareness, (c) alphabetic understanding, and (d) rapid retrieval of phonologically coded information. The composite was an average of the pretest scores and was used as the covariate in subsequent multivariate analyses. However, before conducting a multivariate or univariate analysis, tests for two assumptions of analysis of covariance were conducted, equal means and homogeneity of regression. If both or one of the two assumptions were met, analysis of covariance was conducted to reduce the error term. Reducing the error term means that differences on the measures before the intervention began were partitioned out to increase control over unexplained variability, or rival hypotheses. This was done to increase confidence in attributing differences to the intervention (Good, lecture notes, 1993).

Posttest measures were analyzed through a series of multivariate analysis of variance (MANOVA) or covariance (MANCOVA) for each subsection of question one (i.e., a-d) to determine whether there were significant group differences or differences between the planned comparison contrasts (a) experimental vs control and (b) experimental vs experimental. Significant multivariate effects were followed with respective univariate analyses. Planned comparisons between experimental and control and between the experimental conditions were based on prior research. Specifically, children low in phonological awareness who receive research-based instruction would significantly outperform children in control conditions (Smith et al., 1995). In addition, prior research supported the hypothesis that children with low phonological awareness skills would benefit from instruction that was scaffolded with instruction at the onset-rime level (Slocum et al., 1993).

The analyses and results were organized by results for four or three groups because the non-equivalent-control group did not receive the full complement of tests. This means that analyses were conducted on groups of four or on groups of three when appropriate. In addition, univariate analyses were conducted on the nonsense-word reading and rapid letter-naming measures for four groups. This was done because the non-equivalent control group did not receive all tests in the alphabet understanding group or the rapid naming group of measure. Therefore, it was not possible to conduct multivariate analyses including those measures for four groups. Nevertheless, it was possible to conduct multivariate analyses on the alphabetic understanding and rapid naming groups of measures for three groups.

The selection of a multivariate analysis of variance (MANOVA) procedure was appropriate for three reasons. First, multiple, moderately related measures were used to compensate for the idiosyncrasies of any one test and to better understand the construct of phonological awareness (R. Gersten, class notes, Winter, 1993). Related measures increase sensitivity of response to treatment. See Appendix E for Pretest and Posttest Correlations Matrices. Moreover, moderate correlation among the measures violates an assumption of univariate F statistics making the use of MANOVA more appropriate than ANOVA. Second, MANOVA detects and controls the Type I experiment-wise error, EWI (i.e., accepting differences as statistically significant when they are not) and Type II (i.e., failing to recognize statistically significant differences) (Haase & Ellis, 1987). Third, the present study was grounded in theory and prior research that has hypothesized the existence of constructs and interactions among constructs during the acquisition of reading. Multivariate analyses can address constructs, or linear combinations of indicators of the construct, whereas univariate analyses cannot address constructs, or relations among indicator variables (Haase & Ellis, 1987).

Descriptive statistics were used to describe the number and percentage of children reaching or exceeding minimum levels of proficiency on skills for which normative data were available: (a) TOPA, (b) LAC, (c) Phonemic Segmentation, and (d) Letter-Naming Fluency.

Question 2: Is there a statistically significant difference in the efficiency of the three instructional conditions as measured by:

(a) number of lessons to proficiency on the Phonemic Segmentation Subtest [DIBELS] (1992)?

(b) rate of growth as measured by the slope of performance on the Phonemic Segmentation and Onset Recognition Subtests [DIBELS] (1992)?

Question 2 was analyzed with descriptive and inferential statistical analyses. A one-way between-group analysis of variance (ANOVA) was conducted to determine whether the differences of mean number of sessions to proficiency between groups was statistically significant. Proficiency was determined by the average level of phonemic segmentation for kindergarten children within the district, or 35-45 segments per minute (Good & Kaminski, 1991; Koehler, 1996). The one-way, between-subjects factor was method of instruction (phoneme [WP], onset-rime-phoneme [WORP], equivalent-control [EC], and non-equivalent control [NEC]).

The study examined two estimates of rate of growth over time---slope on Phonemic Segmentation Fluency [PSF] and Onset Recognition Fluency [OnRF] [DIBELS] (Good et al., 1992b). A Hierarchial Linear Modeling procedure was used to estimate the rate of change as defined by slope (Koehler, 1996; Willett, 1988). First, individual slopes were calculated. Then, to adjust for high variability in slopes of very young children, individual slopes were weighted with those having a smaller standard error receiving a greater weight than slopes with a higher standard error (Koehler, 1996: Willett, 1988). The average of weighted individual

slopes for each group was used in a between-groups analysis of variance to identify whether significant differences existed between groups.

Fidelity of Implementation Analysis

Treatment implementation was evaluated with percentage data from the Fidelity of Implementation Checklist. The percentage score per observation represented the number of items present divided by the number of possible items. These percentages scores per observation were averaged across five weeks of observations. Percentages for each item represented the total number items present across five weeks of observation divided by the number of possible items. Then, a series of *t*-tests were conducted to determine whether significant differences occurred between the WAP and the WORP groups on the percentage of all items, as well as the average percentage for each item. In addition, *t*-tests were conducted on the number of opportunities to respond and number of correct responses at the group and individual levels to evaluate comparability of opportunities to respond and mastery. Control conditions were evaluated by analyzing rank ordering of early literacy activities by the regular classroom teachers. A sample of the checklist and the results are provided in Appendix C.

Summary

Sixty kindergarten children were randomly assigned within classroom to one of three instructional groups: (a) WAP, phonological awareness instruction at the

phoneme level, (b) WORP, phonological awareness instruction at the onset-rime level before instruction at the phoneme level, and (c) control, instruction in the regular classroom without any experimental control. In addition, 14 kindergarten children from a third school comprised a non-equivalent control comparison group. The intervention was conducted four times per week in small groups in 15-minute sessions for nine weeks.

The efficacy and efficiency of the phonological awareness interventions were assessed with summative and formative measures at the group level. Separate multivariate analyses of covariance with one between-subjects factor (i.e., instructional condition) and one within-subjects repeated factor (i.e., time of test) were conducted to examine the effects of intervention on efficacy of indicators of (a) phonological awareness, (b) alphabetic understanding, and (c) rapid naming of phonologically coded material. A Hierarchial Linear Modeling procedure was used to examine the efficiency of the interventions, or rate of growth in phonological segmentation and onset recognition and production over a 10-week period.

CHAPTER IV

RESULTS

Results of the study are presented in three sections: (a) descriptive statistics assessing group comparability at pretest, (b) descriptive and inferential statistics addressing two research questions, and (c) descriptive and inferential statistics assessing fidelity of implementation.

Four groups included in the analyses were the two experimental conditions, WAP and WORP, the equivalent control condition, EC, and the non-equivalent control condition, NEC. All measures across pretest, posttest, and delayed posttest were administered to children in the two experimental conditions and the equivalent control conditions. However, children in the non-equivalent control did not receive the full complement of tests at pretest and posttest and were not assessed at delayed posttest. Consequently, analyses were conducted across four groups of measures administered to all groups and conducted across three groups on measures received by only the equivalent control and experimental conditions. Results for pre/post analyses are organized in the following order: (a) descriptive precedes multivariate or univariate analyses and (b) results for four groups precede results for three groups.

Based on recommendation of Haase and Ellis (1987) in their discussion of multivariate analyses, Pillai's trace was chosen as the multivariate statistic because

it is a robust multivariate test statistic. In the present study, analyses of covariance were conducted not only when both, but also when one of the assumptions had been met. In addition to conventional statistics, ETA squared will be reported to extend the report of statistical significance and magnitude of the effect (Haase & Ellis, 1987; Kepel & Zedeck, 1989).

Group Comparability Description

In this section, descriptive statistics are presented for the (a) screening and estimation of verbal ability measures, and (b) all pretest measures organized by theoretical constructs prerequisite to reading acquisition.

Screening and Verbal Ability Performance By Group

Table 6 presents the descriptive statistics for the screening and verbal ability measures. The phonological awareness screening measure [TOPA] and the nonsense-word reading measure [NWF] were administered to all four groups, whereas the vocabulary measure [PPVT-R] was administered to WAP, WORP, and EC only.

Results of separate univariate analyses of variance indicated no statistically significant differences between groups on the phonological awareness screening measure [TOPA], $F(3,70) = 0.14$, $p > .05$; the nonsense-word reading measure [NWF], $F(3, 70) = 0.36$, $p > .05$; or the vocabulary pretest [PPVT-R], $F(2,57) = .66$, $p > .05$. For the phonological awareness screening measure [TOPA], the mean

TABLE 6. Descriptive Statistics for Screening and Verbal Ability Performance

	Group											
	WAP (n=21)			WORP (n=23)			EC (n=16)			NEC (n=14)		
Measure	M	SD	Range	M	SD	Range	M	SD	Range	M	SD	Range
TOPA 20	5.38	1.66	1-7	5.17	1.47	2-7	5.50	1.63	2-7	5.29	1.73	2-7
NWF	1.19	2.06	0-8	0.78	2.02	0-7	1.13	1.54	0-4	1.43	1.99	0-6
PPVT-R	87.76	12.72	65-112	89.52	10.86	70-108	92.88	17.39	32-120	[a]		

[a] The NEC group did not receive the PPVT-R.

Note: The number below the measure label represents the maximum score. TOPA = Test of Phonological Awareness, NWF = Nonsense-Word Reading, and PPVT-R = Peabody Picture Vocabulary Test-Revised. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

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score of 5 of possible 20 items translated to the 16th percentile for young kindergarten children. According to Torgesen and Bryant (1994b), the cut-off percentile for being considered at-risk for reading difficulties was at or below the 32nd percentile.

No children read a nonsense word correctly at pretest. The metric for the nonsense-word reading score [NWF] was correct phonemes per minute, and the range of scores was 0.78-1.43 phonemes per minute. One word comprised three phonemes at minimum.

The mean vocabulary score [PPVT-R] for all groups, 89.8, represented a low-average score as indicated by Dunn and Dunn (1981) in a table of standard equivalent scores on the individual test record. The score used in the analysis was a standard score equivalent with a mean of 100 and a standard deviation of 15.

Pretest Performance By Constructs of Phonological Awareness, Alphabetic Understanding, and Rapid Retrieval

Descriptive statistics for phonological awareness pretest measures, for alphabetic understanding, and for rapid retrieval are presented in Table 7. Mean differences between groups were small on all measures. However, variability within specific pretest measures was large. This was indicated by standard deviations that exceeded the mean score for half the measures, specifically Phonemic Segmentation Fluency, Letter-Naming Fluency, Letter-Sound Fluency, and Nonsense-Word Reading Fluency.

TABLE 7. Descriptive Statistics for Pretest Performance

	Group											
	WAP (n=21)			WORP (n=23)			EC (n=16)			NEC (n=14)		
Measure	M	SD	Range	M	SD	Range	M	SD	Range	M	SD	Range
Phonological Awareness												
PSF	8.67	11.23	0-41	6.78	7.55	0-27	5.69	8.81	0-30	6.81	8.33	0-28
OnRF	11.40	9.45	2-43	8.09	5.08	.88-22	7.20	6.72	0-21	7.01	4.08	0-13
Blend (29)	6.45	5.14	0-17	5.60	4.25	0-20	7.13	4.76	0-16	5.14	4.50	0-12
LAC (100)	21.25	15.55	0-63	20.90	10.20	36-46	20.27	10.96	7-47	[a]		
Alphabetic Understanding												
NWF	1.25	2.10	0-8	0.90	2.15	0-7	1.20	1.57	0-4	1.43	1.99	0-6
LSF	1.15	2.13	0-9	0.40	0.82	0-3	1.27	1.71	0-6	[a]		
Rapid Retrieval												
RCNF	40.31	14.79	0-65	37.39	13.80	2-62	33.28	12.19	3-54	34.79	18.71	0-62
LNF	9.81	9.86	0-26	8.00	9.44	0-33	11.38	13.59	0-38	[a]		

[a] NEC did not receive the designated measures.

Note: Numbers in parentheses under the test names indicate maximum possible test scores for accuracy measures. PSF = Phonemic Segmentation Fluency, OnRF = Onset Recognition Fluency, LAC = the Lindamood Auditory Conceptualization Test, LNF = Letter-Naming Fluency, RCNF = Rapid Color Naming Fluency, and LSF = Letter-Sound Fluency. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Findings of separate of univariate analyses of variance indicated no statistically significant differences between groups on any of the pretest measures. The statistics for phonological awareness measures included (a) Phonemic Segmentation Fluency, $F(3, 57) = 0.31$, $p > .05$, (b) Onset Recognition Fluency, $F(3, 63) = 1.57$, $p > .05$, (c) Blending, $F(3, 65) = 0.55$, $p > .05$, and (d) LAC, $F(2, 52) = 0.03$, $p > .05$. Alphabetic understanding measures included (a) Nonsense-Word Reading Fluency, $F(3, 65) = 0.21$, $p > .05$, and (b) Letter-Sound Naming Fluency, $F(2, 52) = 1.53$, $p > .05$. Rapid retrieval measures included (a) Rapid Color-Naming Fluency, $F(2, 51) = 1.10$, $p > .05$ and (b) Letter-Naming Fluency, $F(2, 52) = 0.42$, $p > .05$. Children who scored less than 30 out of 36 correct on the Rapid Color-Naming Fluency [RCNF] test were not included in the analysis because the test was invalid for its purpose if children did not know the colors.

Two Research Questions

The following section reports the results for the two research questions formulated to examine the efficacy and the efficiency of two phonological awareness interventions and includes results organized in the following subsections: (a) phonological awareness, (b) alphabetic understanding, (c) rapid retrieval of phonologically coded information,(d) thresholds, (e) time to proficiency, and (f) rate of growth. When appropriate, each subsection is prefaced by descriptive statistics followed by results of analyses. The non-equivalent control group [NEC] did not

receive the full complement of tests. Therefore, when applicable, the results for all four groups are reported first, followed by results for three groups.

Measures for the multivariate analyses were organized into three groups of constructs derived from theory and empirical evidence that indicate a strong relation among phonological awareness, alphabetic understanding, and rapid retrieval in learning to read successfully (Smith et al., 1995). In addition, the phonological awareness construct was divided into two groups of measures. One group specifically targeted skills that were the focus of the intervention (i.e., segmentation, blending, and onset recognition), whereas the other group represented untaught phonological skills that would require generalization (i.e., TOPA, LAC).

Two contrasts supported by prior research and theory were used in the analyses: (a) experimental groups versus control group[s] [WAP+ WORP vs. EC + NEC when appropriate or WAP + WORP vs. EC], and (b) experimental versus experimental [WAP vs. WORP].

Phonological Awareness

Descriptive Statistics for Specific Measures of Phonological Awareness Across Four Groups

Table 8 presents descriptive statistics for segmentation [PSF], onset recognition [OnRF], and blending [BLND] at pre-, post-, and delayed posttest. Delayed posttests were not administered to the non-equivalent control group. The measures represented direct indicators of skills targeted during the intervention.

TABLE 8. Descriptive Statistics for Pretest, Posttest, and Delayed Posttest Performance On Specific Measures of Phonological Awareness Across Four Groups[a]

		Pretest		Posttest		Delayed	
Group	Measure	M	SD	M	SD	M	SD
WAP	PSF	8.88	11.24	26.61	14.07	31.49	15.51
n = 19	OnRF	11.40	9.45	23.58	12.66	22.42	11.73
	Blend	6.45	5.14	12.22	6.51	14.05	6.60
WORP	PSF	6.78	7.55	22.72	14.11	26.94	19.15
n = 20	OnRF	8.09	5.08	18.34	10.64	21.91	9.71
	Blend	5.60	4.25	10.40	4.37	12.05	6.62
EC	PSF	5.69	8.81	12.69	13.67	12.30	17.59
n =13	OnRF	7.20	6.72	17.02	12.14	18.07	8.52
	Blend	7.13	4.76	8.67	5.72	9.21	4.02
NEC	PSF	6.81	8.34	14.45	16.18	[a]	
n =14	OnRF	7.01	4.07	10.46	5.57	[a]	
	Blend	5.14	4.50	7.07	4.16	[a]	

[a] The NEC group did not receive delayed posttests.
Note: PSF = Phonemic Segmentation Fluency, OnRF = Onset Recognition Fluency. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Group means improved from pretest to posttest and maintained or exceeded that improvement at delayed posttest with the exception of onset recognition [OnRF] for WAP and segmentation [PSF] for EC.

Results of Multivariate Analyses for Specific Measures of Phonological Awareness at Posttest Across Four Groups

Table 9 displays results of a multivariate analysis of covariance (MANCOVA) performed on three measures of phonological awareness---segmentation, blending, and onset recognition across four groups. The MANCOVA indicated no reliable differences between groups based on Pillai's trace. Pillai's trace was employed because it is the most robust multivariate test statistic (Haase & Ellis, 1987). The MANCOVA performed on two planned comparisons indicated: (a) statistically significant differences between the experimental and the control conditions [WAP + WORP vs. EC + NEC] with 0.15 for magnitude of effects based on ETA squared, and (b) no statistically significant differences between WAP and WORP based on Pillai's test. Follow-up univariate analysis of variance for the reliable difference between experimental and control groups indicated that Phonemic Segmentation Fluency, Onset Recognition Fluency, and Blending contributed to the significant differences between the experimental and the control conditions.

Results of Multivariate Analysis on Specific Measures of Phonological Awareness at Delayed Posttest Across Three Groups

Table 10 presents results from a multivariate analysis of covariance conducted on three delayed posttest measures, Phonemic Segmentation Fluency

TABLE 9. Summary of Multivariate Analysis of Covariance on Specific Measures of Phonological Awareness At Posttest Performance Across Four Groups

Source of Variation	Multivariate F	df	p	Follow-up Univariate F: ETA Squared	PSF	OnRF	BLND	df
Covariate	13.09*	3, 59	<.01	0.40				
Group	1.78	9, 183	0.08	0.08				
Contrast 1	3.69*	3, 61	0.02	0.15	8.45*	6.00*	5.37*	1,63
Contrast 2	0.25	3, 33	0.86	0.02				

*$p < .05$.

Note. Planned comparisons are: contrast 1 between experimental and control conditions [WAP + WORP vs. EC+ NEC], contrast 2 between experimental conditions [WAP vs. WORP]. Follow-up univariate ANOVAs conducted only for significant overall effects. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

[PSF], Onset-Recognition Fluency [OnRF], and Blending [BLND]. The MANCOVA indicated no significant effects between groups, although with a p value of 0.08 and the magnitude of effect at 0.11 the effect between groups approached significance. No reliable differences were found between the experimental and control groups, or between the experimental groups.

TABLE 10. Summary of Multivariate Analysis of Covariance of Specific Measures of Phonological Awareness on Delayed Posttest Performance Across Three Groups

Source of Variation	Multivariate F	df	p	ETA Squared
Covariate	8.64**	3, 46	0.00	0.36
Group	1.99	6, 98	0.08	0.11
Contrast 1	2.24	3, 47	0.10	0.13
Contrast 2	0.25	3, 33	0.86	0.02

**$p < .001$.
Note. Planned comparisons are: contrast 1 between experimental and control conditions [WAP + WORP vs. EC], contrast 2 between experimental conditions [WAP vs. WORP]. WAP = phoneme condition, WORP = onset condition, EC = equivalent control.

Descriptive Statistics for General Measures of Phonological Awareness Across Three Groups

Table 11 presents descriptive statistics for two general measures of phonological awareness at pretest and posttest [TOPA, LAC]. Findings indicated that group means for all groups improved from pretest to posttest across both measures.

TABLE 11. Descriptive Statistics for Pretest and Posttest Performance on General Measures of Phonological Awareness Across Three Groups

		Pretest		Posttest	
Group	Measure	M	SD	M	SD
WAP	LAC	21.25	15.54	24.95	13.87
n = 19	TOPA	5.38	1.66	11.50	4.61
WORP	LAC	20.90	10.20	24.33	15.12
n = 20	TOPA	5.17	1.47	10.22	3.52
EC	LAC	20.27	10.96	23.21	12.78
n =13	TOPA	5.50	1.63	9.14	3.70
NEC	LAC	[a]			
n = 14	TOPA	[a]			

[a] NEC did not receive the designated tests.
Note: LAC = the Lindamood Auditory Conceptualization test, TOPA = the Test of Phonological Awareness. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Results of Multivariate Analyses for General Measures of Phonological Awareness at Posttest Across Three Groups

Table 12 displays results of a multivariate analysis of covariance (MANCOVA) performed on two measures of phonological awareness [LAC, TOPA]. The MANCOVA indicated no reliable differences between groups or for planned comparison experimental versus control or for WAP vs. WORP based on Pillai's trace.

TABLE 12. Summary of Multivariate Analysis of Covariance on General Measures of Phonological Awareness At Posttest Performance Across Three Groups

Source of Variation	Multivariate F	df	p	ETA Squared
Covariate	4.39*	2, 50	0.02	0.15
Group	0.86	4, 102	0.49	0.03
Contrast 1	0.98	2, 51	0.38	0.04
Contrast 2	0.69	2, 36	0.51	0.04

*$p < .05$.
Note. Planned comparisons are: contrast 1 between experimental and control conditions [WAP + WORP vs. EC], contrast 2 between experimental conditions [WAP vs. WORP]. WAP = phoneme condition, WORP = onset condition, EC = equivalent control.

Summary of Multivariate Analyses on Specific and General Measures of Phonological Awareness

In summary, analyses were conducted on two groups of phonological awareness measures, specific measures of skills targeted in the intervention and general measures of skills beyond the focus of the intervention. Multivariate analyses of covariance indicated no reliable overall differences between groups or on the second planned contrast between WAP and WORP on either group of measures on post or delayed posttest.

However, performance on specific measures of segmentation, blending, and onset recognition at posttest indicated reliable differences for the planned contrast

between the experimental and control conditions [WAP + WORP vs. EC + NC] at posttest. The effects were attributed to differences in segmenting, onset recognition, and blending. Nevertheless, the reliable differences were not maintained at delayed posttest.

Alphabetic Understanding

Descriptive Statistics

Letter-Sound Naming Fluency and Nonword Reading Fluency were used as indicators of alphabetic understanding. Table 13 presents the pretest and posttest means and standard deviations for each measure across groups. Although all groups improved performance across both measures from pretest to posttest; all standard deviations were large, exceeding the mean for both measures across time of testing.

Results of Univariate Analysis of Variance On Nonsense-Word Reading Fluency Across Four Groups

Results of a univariate analysis of variance on NWF across four groups as presented in Table 14 indicated no reliable differences between groups at posttest, or on two planned contrasts between experimental and control and between WAP and WORP.

TABLE 13. Descriptive Statistics for Alphabetic Understanding Pretest and Posttest Performance

		Pretest		Posttest	
Group	Measure	M	SD	M	SD
WAP	NWF	1.25	2.10	4.05	4.56
n = 19	LSF	1.15	2.13	3.20	3.63
WORP	NWF	0.90	2.15	1.85	3.36
n = 20	LSF	0.40	0.82	1.70	2.58
EC	NWF	1.20	1.57	3.87	6.78
n =13	LSF	0.91	1.66	2.80	5.52
NEC	NWF	1.43	1.99	2.71	4.29
n =14	LSF	[a]	[a]		

[a] NEC did not receive the full battery of tests.
Note: NWF = Nonsense-Word Reading Fluency, and LSF = Letter-Sounds Naming Fluency. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

TABLE 14. Summary of Univariate Analysis of Variance for Nonsense Word Reading Fluency at Posttest Across Four Groups

Source of Variations	F	df	p	ETA Squared
Group	1.19	2,52	0.31	0.04
Contrast 1	0.09	1,67	0.76	0.001
Contrast 2	3.02	1,38	0.09	0.07

Note: Planned comparisons are: contrast 1 between experimental and control conditions [WAP + WORP vs. EC + NEC], contrast 2 between experimental conditions [WAP vs. WORP]. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Results of Multivariate Analysis of Variance on Alphabetic Understanding Across Three Groups

As shown in Table 15, a multivariate analysis of variance (MANOVA) performed on two measures of alphabetic understanding (i.e., Nonsense-Word Reading Fluency [NWF] and Letter-Sound Naming Fluency [LSF]) indicated no reliable differences between groups based on Pillai's trace or between either planned contrast: (a) contrast 1 between experimental and control conditions [WAP+ WORP vs. EC] and (b) contrast 2 between experimental conditions [WAP vs. WORP].

TABLE 15. Summary of Multivariate Analysis of Variance on Alphabetic Understanding Measures At Posttest Performance Across Three Groups

Source of Variation	Multivariate F	df	p	ETA Squared
Group	0.63	4, 104	0.64	0.02
Contrast 1	0.19	2, 52	0.83	0.01
Contrast 2	1.93	2, 37	0.16	0.09

Note. NWF = Nonsense-Word Reading Fluency and LSF = Letter-Sounds Naming Fluency. Planned comparisons are: contrast 1 between experimental and control conditions [WAP + WORP vs. EC], contrast 2 between experimental conditions [WAP vs. WORP]. WAP = phoneme condition, WORP = onset condition, EC = equivalent control.

Retrieval Rate for Phonologically Coded Material

Descriptive Statistics

Table 16 presents descriptive statistics for two measures used as indicators of retrieval rate of phonologically coded information, Rapid Color-Naming Fluency [RCNF] and Rapid Letter-Naming Fluency [LNF]. The means indicated that all groups improved across time for both measures. Standard deviations for letter-naming remained large across time of test.

TABLE 16. Descriptive Statistics for Retrieval Rate for Pretest and Posttest Performance

		Pretest		Posttest	
Group	Measure	M	SD	M	SD
WAP	RCNF	41.16	14.73	42.00	10.60
n = 19	LNF	9.95	10.09	15.85	14.57
WORP	RCNF	37.39	13.80	41.22	14.82
n = 20	LNF	8.65	9.94	14.45	14.63
EC	RCNF	33.28	12.19	36.26	15.96
n =13	LNF	12.13	13.72	18.87	17.46
NEC	RCNF	34.77	18.71	37.95	15.16
n =14	LNF	[a]			

[a] NEC did not receive the full complement of tests.
Note: RCNF = Rapid Color-Naming Fluency, LNF = Letter-Naming Fluency. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Results of Univariate Analysis of Covariance
on Rapid-Color Naming Fluency
Across Four Groups

Results of a univariate analyses of covariance conducted for the Rapid Color-Naming Fluency [RCNF] across four groups, presented in Table 17, indicated no reliable differences between groups or for any contrasts on the rapid-naming measures at posttest.

TABLE 17. Summary of Univariate Analyses of Covariance at Posttest on Rapid-Color Naming Fluency [RCNF] Across Four Groups

Source of Variation	F	df	p	ETA Squared
Covariate	22.74**	1,49	.000	.32
Group	0.22	2,49	.81	.01
Contrast 1	1.21	1,51	.28	.02
Contrast 2	0.14	1,35	.71	.004

**$p < .001$
Note: Planned comparisons are: contrast 1 between experimental and control conditions [WAP + WORP vs. EC + NEC], contrast 2 between experimental conditions [WAP vs. WORP]. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Results of Multivariate Analysis of
Covariance On Rapid Retrieval

As displayed in Table 18, results from a multivariate analysis of covariance (MANCOVA) performed on two measures of rapid retrieval across three groups

TABLE 18. Summary of Multivariate Analysis of Covariance for Retrieval Rate Measures On Posttest Performance Across Three Groups

Source of Variation	Multivariate F	df	p	ETA Squared
Covariate	49.83**	2, 47	0.00	
Group	0.72	4, 100	0.58	0.03
Contrast 1	1.35	2, 50	0.27	0.05
Contrast 2	0.15	2, 35	0.86	0.01

**p < .001

Note. Planned comparisons are: contrast 1 between experimental and control conditions [WAP + WORP vs. EC], contrast 2 between experimental conditions [WAP vs. WORP]. WAP = phoneme condition, WORP = onset condition, EC = equivalent control.

indicated no reliable differences between groups, between experimental and control, or between two experimental conditions based on Pillai's trace. Lack of significance and an effect size of .028 indicated that within-group variability explained more of the effects than the intervention.

Summary of Multivariate and Univariate Analyses on All Measures At Posttest and Delayed Posttest

No statistically significant differences were found between groups or for any planned comparison contrast with the univariate analyses of variance for nonsense-word reading or rapid-color naming across four groups. Similarly, no results of multivariate analyses of variance indicated overall statistically significant

differences between groups on any group of measures. Analyses for two planned contrasts indicated the following. Reliable differences were found between the experimental and control groups [WAP + WORP vs. EC + NEC] at posttest on specific measures of phonological awareness with Phonemic Segmentation Fluency, Onset Recognition Fluency, and Blending contributing significantly to that difference. No reliable differences were found between the experimental groups, WAP and WORP, on any group of measures.

Thresholds

Table 19 presents numbers and percentages of children who met or exceeded thresholds at posttest on measures with normative or threshold information (Good & Kaminski, 1991, Koehler, 1996; Lindamood & Lindamood, 1979; Torgesen & Bryant, 1994b). Greater numbers of children who received intervention met or exceeded threshold levels than children in control conditions with the exception of the letter-naming threshold [LNF].

Weeks to Proficiency

A one-way analysis of variance with group as the between-subjects factor indicated no significant differences between groups on the number of weeks to proficiency on segmentation fluency, $F(2, 19) = 1.67$, $p > .05$. Table 20 presents a summary of the mean number of weeks to proficiency, the standard deviation, range, and number and percentage of children who reached proficiency. Children

TABLE 19. Percentage of Children Reaching Threshold Levels of Performance

Group	n	Number of Children of Reaching Threshold (Percentage Reaching Threshold)			
		LAC	TOPA	PSF	LNF
WAP	19	3 (15%)	16 (80%)	10 (48%)	4 (20%)
WORP	20	3 (14%)	16 (80%)	9 (39%)	3 (14%)
EC	13	1 (6%)	8 (53.3%)	3 (19%)	5 (33%)
NEC	14	[a]	[a]	2 (14%)	[a]

[a]NEC did not receive the designated tests.
Note: The first number under the measure name is the number of children, the second number in parenthesis is the percentage of children reaching threshold. Thresholds are defined as: Total score of 40 on the LAC, Minimum percentile of 30 on TOPA, 35-45 segments per minute for PSF, 38-42 on LNF. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

were excluded from the analysis who had six or less of the possible 10 weeks of data. Although the difference was not statistically significant, children in the WAP group reached proficiency in fewer weeks than those in the WORP group, $F(1,17) = 2.08$, $p > .05$.

TABLE 20. Mean Number of Weeks to Phonemic Segmentation Proficiency

Group	n	Mean Number Weeks to Proficiency	SD	Range	Number of Children of Reaching Proficiency	Percentage Reaching Proficiency
WAP	21	6.09	3.05	1-10	10	48
WORP	23	8.11	1.96	4-10	9	39
EC	16	5.67	.58	5-6	3	19
NEC	14[a]					

[a]NEC did not receive progress monitoring.
Note: The number is parenthesis is the number of children who reached proficiency within 10 weeks and were considered in the analysis. A week comprised three lessons in four sessions. The study comprised 10 weeks of weekly monitoring. Proficiency is defined as 35-45 segments per minute. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Rate of Growth

Regression analyses were performed on Phonemic Segmentation Fluency [PSF] and Onset Recognition Fluency [OnRF] by employing a Hierarchial Linear Modeling procedure (Willett, 1988) to adjust for variability on individual slopes. See Appendix F for examples of betas (slope), variances, and weights. Children with less than 6 of 10 of the possible data points were excluded from the analysis. Table 21 displays the number of children included in the analysis, weighted group means, and standard deviations for Phonemic Segmentation Fluency and Onset

TABLE 21. Descriptive Statistics for Slopes of Phonemic Segmentation Fluency and Onset Recognition Fluency

	PSF					OnRF				
Group	n	Mean	Weighted Mean	SD	Range	n	Mean	Weighted Mean	SD	Range
WAP	20	2.01	1.80[a]	1.58	-0.90-5.38	20	1.26	1.02[a]	0.99	-0.12-3.00
WORP	19	1.94	0.64[ab]	1.77	-1.38-5.29	23	1.35	0.97[ab]	0.93	-0.60-2.92
EC	15	0.96	1.17[b*]	1.28	-0.98-3.10	16	1.07	0.70[b]	1.00	-0.20-3.50
NEC	14**									

*$p < .01$.
** NEC did no receive progress monitoring.
Comparisons that share the same superscript are not significant at the pairwise alpha of 0.0167 [i.e., based on familywise alpha of 0.05 divided by 3 pairwise comparisons].
Note: n is the number of children with valid observations. Weighted means were calculated by averaging individual means that had been weighted with the inverse of individual slope variability. WAP = phoneme condition, WORP = onset condition, EC = equivalent control, NEC = non-equivalent control.

Recognition Fluency. The weighted mean is the average of individual slopes that have been weighted for individual variability. Using the Least Squares Means procedure, three pair-wise comparisons indicated reliable differences between WAP and EC and no reliable differences between WAP and WORP or between WORP and EC. Bonferroni additive inequality was used to control Type I experiment-wise error.

Fidelity of Implementation

Experimental Conditions

High fidelity of implementation was indicated by a series of *t*-tests indicating no overall reliable differences between experimental groups and no reliable differences on features of implementation. Specifically, there were no significant differences in the total percentage of items observed, $t(14) = 0.62$, $p > .05$. The mean percentage of implemented items for WAP was 93.75% and 92.50% for WORP. Similarly, *t*-tests indicated no reliable differences in the number of opportunities to respond as a group, $t(14) = -0.13$, $p > .05$; or as an individual, $t(14) = 0.14$, $p > .05$; in the number of group errors, $t(8) = -1.21$, $p > .05$; or individual errors, $t(14) = -1.34$, $p > .05$. Table 22 presents the means and standard deviations for opportunities to respond and number of errors.

Mastery was calculated by dividing number of correct responses by number of opportunities to respond. Mean percentages of mastery at the group level (i.e., 85% for WAP, 75% for WORP), and at the individual level (i.e., 83% for WAP,

TABLE 22. Opportunities to Respond and Errors at the Group and Individual Levels

		Opportunities to Respond				Errors			
		Group		Individual		Group		Individual	
Group	n	M	SD	M	SD	M	SD	M	SD
WAP	8	10.13 (3-29)	8.59	7.75 (3-18)	5.20	1.50 (0-4)	1.20	1.13 (0-3)	1.36
WORP	8	10.63 (4-24)	6.46	7.38 (0-18)	5.29	2.13 (1-3)	0.83	2.38 (0-6)	2.26

Note. WAP = phoneme condition, WORP = onset condition. The number in parenthesis indicates the range, n is the number of observations.

68% for WORP) indicated that although the two conditions were implemented at similar levels of fidelity on designated items, WAP and WORP did not achieve similar levels of mastery across group and individual levels of response.

Control Conditions

At the completion of the intervention, regular classroom teachers prioritized a listing of early literacy activities. A sample of the checklist is provided in Appendix C. The checklist was used to gain a sense of classroom teachers' differential emphases on skills related to early literacy. Emphasis was defined as the rank ordering of activities by the teachers. Reading-a-loud, letter-sound correspondence instruction, and writing were ranked one, two, and three,

respectively across schools. In addition, teachers were asked if there had been a change of emphasis over the nine weeks of intervention. One teacher from School B (an equivalent control condition) and one teacher from School C (the non-equivalent control condition) reported that less emphasis was given to instruction in rhyming and letter-names, whereas, increased emphasis was given to writing and letter-sound correspondence instruction. See Appendix C for Summary Table of Results.

CHAPTER V

DISCUSSION

This chapter will address the following: (a) integration of research, (b) limitations, (c) implications for phonological awareness instruction in kindergarten, (d) directions for future phonological awareness research, and (e) conclusion.

Integration of Research

The purpose of this study was to examine the efficiency and efficacy of two phonological awareness interventions on the acquisition and retention of phonological awareness skills for kindergarten children low in phonological awareness. Specifically, the study examined the potential advantage of beginning phonological awareness instruction at the onset-rime level before proceeding to the phoneme level, in contrast to instructing at the phoneme level directly. Prior research has suggested that the onset-rime level may serve as a necessary step for children low in phonological awareness (Liberman & Shankweiler, 1985; Slocum et al., 1993; Stahl & Murray, 1994; Treiman, 1992). Although findings corroborated prior research documenting the positive effects of phonological awareness intervention on phonological awareness development, results from the present study did not support a significant advantage of either the onset-rime or the phoneme level approach for children low in phonological awareness. The discussion is

organized by four major findings and their relation to the issues and methodologies addressed in the present study.

1. Instruction directly at the onset-rime and phoneme levels were equally effective and efficient.

2. Prereaders with no or limited letter-sound knowledge profited from instruction at the phoneme level .

3. Experimental phonological awareness instruction resulted in greater progress on an array of indicators of phonological awareness development than control conditions.

4. Phonological awareness instruction had differential effects on indicators of phonological awareness.

Experimental Phonological Awareness Conditions Were Equally Effective And Equally Efficient

The primary issue investigated by the study asked: Will teaching at the onset-rime level prior to teaching at the phoneme level mediate the complexity of the phoneme level tasks more effectively and efficiently than teaching directly at the phoneme level? The study provided limited statistical advantage for using one experimental intervention over the other to develop phonemic awareness in that: both experimental conditions were similarly effective and efficient. The study did not provide statistical support for the hypothesized advantage of using onset-rime as a mediated scaffolding step prior to instruction at the phoneme level.

Multiple measurement methodologies (i.e., formative and summative) and measurement constructs (i.e., phonological awareness, alphabetic understanding, and rapid retrieval) were employed in an effort to better understand differential response to instruction. The traditional pretest/posttest and formative methodologies indicated no reliable differences between experimental conditions on any of the measures. Corroboration across results of five measures of phonological awareness offered additional support for the conclusion that the interventions were similarly effective. In addition, random assignment within classroom, a control group to explain alternative hypotheses, fidelity of implementation data across groups, and interventionists teaching both conditions to minimize possible teacher effects strengthened the internal validity of the results (Kepel & Zedeck, 1989).

However, the present study indicated that kindergarten children could profit from instruction directly at the phoneme level without the mediated step of instruction at the onset-rime level. This finding is not inconsequential for children at-risk of reading failure as being able to begin at the phoneme level in essence buys more opportunity for children to learn and lessens the tyranny that time exerts over students who enter school without prerequisite skills (Kameenui, 1993). The critical importance of efficient instruction for prerequisite reading skills necessary for successful reading acquisition in first-grade is substantiated by the following evidence from prior research. There exists high probability of remaining a poor reader if reading acquisition is not well established in first-grade (Juel, 1988). The gap between good and poor readers widens over time and is largely attributed to

differences in phonological awareness and vocabulary (Stanovich, 1986). Most important, research has established that research-based phonological awareness interventions for children low in phonological awareness significantly improves the development of phonological awareness. Thus, emerging evidence is establishing how to bring many of the children who enter behind their peers up to the starting line with early identification and early intervention.

In addition, the following evidence, albeit not statistical, provided additional descriptive support for the phoneme condition [WAP]: (a) WAP means were consistently higher than WORP means across phonological awareness measures and times of test, (b) a higher percentage of children in the WAP group reached the threshold of phonemic segmentation than those in the WORP group, (c) on average, children in the WAP group reached proficiency in fewer weeks than children in the WORP group, and (d) a higher percentage of children in the WAP condition reached mastery as evidenced by the fidelity of implementation data.

The lack of reliable statistical differences between the experimental conditions may be attributable, in part, to limitations in the design of instruction and methodology. First, the instructional design difference between the interventions may have been too subtle to detect with imprecise measures, immature participants, and the short length of differentiating phases of the intervention. Specifically, a sharp contrast between approaches occurred only during presentation of last sound [WAP] versus last sounds [WORP] during weeks six and seven.

Warm-up was based on rhyming which included instruction in last sounds (i.e., rime) and was identical across interventions and represented an overlap in onset-rime condition for both groups. The warm-up phase with instruction in the rime of the onset-rime unit may have been sufficient for the WAP group as a scaffolded step of instruction. Then, first sound instruction during weeks two though five was identical as the target sound-unit was a single sound for both groups. Although the onset-rime group heard the word pronounced as two units (i.e., /m/ /an/ in contrast to /m/-/a/-/n/), instructional emphasis was on the onset or single first sound. Sharp differences occurred only during weeks six and seven as both groups had identical instruction at the phoneme level during weeks eight and nine. Last, both groups had two and half weeks of identical instruction on target skills just prior to posttesting. Except for progress monitoring, the measurement methodology employed in the present study was not designed to detect differences during the last-sound phase of instruction. A midpoint test administered while groups were receiving different instruction on trained and untrained examples may have identified reliably different responses to instruction.

Understanding the relative efficiency of approaches to phonological awareness instruction is theoretically and practically important. Phonological awareness is a necessary but insufficient prerequisite for reading acquisition with limited, but highly critical importance in the scope and sequence of reading acquisition (Chard et al., 1995; Smith et al., 1995). Moreover, Simmons' (1992) notion of "reading disability as an acute condition with a critical intervention

period" (p. 68) highlights the critical finding of the present study that children low in phonological awareness can benefit from instruction in the most difficult of the skills targeted, segmentation (Yopp, 1988) and at the most difficult level, the phoneme (Lyon, 1995; Stahl & Murray, 1994).

Prereaders With No or Limited Letter-Sound Knowledge Can Profit From Phoneme Level Instruction

The study addressed a second issue: Is phonological awareness at the phoneme level dependent upon letter-sound knowledge or can the difficulty of phoneme-level tasks be mediated by instructional variables before letter-sound knowledge acquisition? Findings have theoretical implications for the current issue whether children can access the phoneme level without concurrent instruction in components of alphabetic understanding (Bowey, 1994; Bowey & Francis, 1991; Stanovich, 1994; Torgesen & Davis, in press). Results indicated that kindergarten children could achieve levels of proficiency at the phoneme level with purely auditory activities in less than the usual nine weeks of research-based interventions (Smith et al., 1995). This conclusion is supported by: (a) screening to establish that children had little to no letter-sound correspondence knowledge, (b) no significant effects on posttest performance for alphabetic understanding and low posttest scores for nonsense word reading and letter-sound naming performance, (c) a small percentage of students who reach threshold in letter-naming fluency at posttest (i.e., 20% WAP and 14% WORP), (d) reliably stronger performance by experimental groups than control groups on segmentation, blending, and onset

recognition, and (e) children in the phoneme level group reached proficiency in an average of six weeks. These findings suggest that with limited alphabetic understanding, there seems to be limited, if any reciprocal benefit of phonological awareness understanding on alphabetic understanding.

However, the research design and the findings did not indicate whether concurrent instruction in letter-sound correspondence would have been more advantageous or detrimental on phonological awareness development. Prior research documents a significantly greater advantage of letter-sound and phonological awareness instruction on reading and spelling acquisition than letter-sound correspondence alone (Ball & Blachman, 1991; Spector, 1995). However, no studies with kindergarten children have controlled the timing for optimum integration of phonological awareness and letter-sound correspondence instruction. The present study extended the current research base by indicating that children can make significant progress on phonological awareness skills prior to full development of alphabetic knowledge with research-based curricula and procedures.

The present study did not include observation of letter-sound knowledge instruction in the regular classroom. Teacher reports of the instructional emphases in the regular classrooms indicated out of possible five teachers that letter-sound correspondence instruction was ranked first by two teachers, second by one teacher, third by one teacher, and fourth by one teacher. Letter-name instruction was ranked second by one teacher and fourth by two teachers. Only two teachers reported that their instructional emphases over the intervention changed from reading-a-loud to

alphabetic-knowledge activities. Therefore, the conclusion cannot be made that phonological awareness occurred in the total absence of letter-sound instruction. All children could have received considerable regular letter-sound instruction in the regular classroom and profited from the reciprocal relation that exists between phonological awareness and alphabetic knowledge development. Alphabetic knowledge includes letter-name and letter-sound instruction; however, the key to understanding the relation between print and speech is understanding the connection between letters and sounds of letters. Although group means for rapid letter-naming and letter-sound fluency improved from pretest to posttest, the means remained low. For example, the range for letter-naming was 14.45-18.87 letters per minute and for letter-sound 1.70-3.20 letter-sounds per minute at posttest. The area norm for adequate skill in letter-naming for first-grade reading acquisition is 35-45 letters per minute (Good & Kaminski, 1991; Koehler, 1996); therefore, these data indicate that the regular classroom instruction did not bring children to the level of full alphabetic understanding. A local norm has not been established for letter-sound naming. That no reliable differences were found between groups on alphabetic understanding measures also indicated that letter-sound knowledge remained constant across groups.

Experimental Instruction Resulted in Greater Progress on An Array of Indicators of Phonological Awareness Development than Control Instruction

The present study was based on a large body of empirical evidence establishing that explicit small-group instruction in phonological awareness is necessary for children low in phonological awareness. Findings supported prior research documenting that prereaders low in phonological awareness who receive research-based phonological awareness instruction make significantly greater progress in phonological awareness development than children in control conditions (Brady et al., 1994; O'Connor et al., 1993; O'Connor et al., 1995; Slocum et al., 1993; Torgesen et al., 1992; Torgesen & Davis, in press). Children in experimental conditions outperformed children in control conditions on phonological awareness skills targeted in the intervention.

That the performance of the control group was reliably lower than performance of the experimental group on direct measures of phonological awareness is important for two reasons. First, the reliable difference supported the hypothesis that explicit, systematic phonological awareness instruction was responsible for progress made by children in the experimental groups. Second, the results support the need for more intense instruction than is provided in the regular classroom for children low in phonological awareness (Blachman, 1994; Torgesen et al., 1994). Specifically, reports of teachers in the regular classrooms indicated that children were receiving some incidental phonological awareness and letter-sound correspondence instruction in the regular classroom. However, the results

indicated that neither the amount nor the intensity of instruction was sufficient for children with an "acute condition" of low phonological awareness (Simmons, 1992, p. 68). In addition, the study added evidence to an emerging critical mass of studies that targets prereaders low in phonological awareness (O'Connor et al., 1993; O'Connor et al., 1995; Torgesen et al., 1992; Torgesen & Davis, in press) by supporting significant advantages to explicit phonological awareness instruction in small-groups for children with low phonological awareness.

Additional support for the conclusion that experimental condition resulted in significantly better performance on specific indicators of phonological awareness skills targeted in the intervention was indicated by the static performance on phonemic segmentation for children in the control condition from posttest to delayed posttest in contrast to performance of children in experimental conditions. This between-group difference from posttest to delayed posttest, albeit not statistically significant, suggested that although children in experimental and control conditions received the same instruction between posttest and delayed posttest, the phonological intervention may have explained the gains from posttest to delayed posttest for the children in the experimental conditions. The lack of statistical significance at delayed posttest may be related to the decrease in number of scores used in the analyses as the non-equivalent control group participated in posttesting but not in delayed posttesting. See Figure 1 for differences in performance on segmentation across groups and times of test.

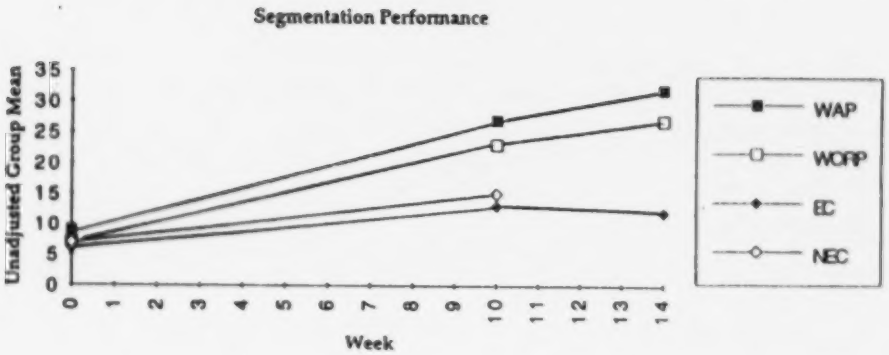

FIGURE 1. Phonemic Segmentation Fluency performance across groups at pretest, posttest, and delayed posttest.

Note. WAP is instruction directly at the phoneme level, WORP is instruction at the onset-rime level prior to instruction at the phoneme level, EC is the equivalent control group, and NEC is the non-equivalent control group. The non-equivalent control group did not receive delayed posttests.

Differential Effects on Indicators of Phonological Awareness

A final issue addressed by the present study was the role that measures play in understanding learners' response to instruction. Specifically, the following feature will be discussed: convergence on skill development with multiple measures.

Convergence on Skill Development with Multiple Measures

For young children low in phonological awareness, the present intervention differentially affected performance on Phonemic Segmentation Fluency, Blending, Onset Recognition Fluency, the Test of Phonological Awareness [TOPA], and the Lindamood Auditory Conceptualization test [LAC]. Significant differences between groups were exhibited on the group of specific measures relating to results of multivariate analyses (i.e., Phonemic Segmentation, Blending, and Onset Recognition Fluency), on all three measures with univariate analyses, and on Phonemic Segmentation Fluency with Hierarchial Linear Modeling procedure. Those measures represented specific measures of skills targeted in the interventions. In contrast, the interventions did not affect generalization to untaught phonological awareness skills as indicated by student performance on general measures (i.e., TOPA, LAC).

The most plausible explanation why significant differences were found with segmentation, blending, and onset recognition measures but not the TOPA or the LAC measures resides in the lack of generalization phenomenon documented in a range of phonological awareness studies. Several lines of research have been examining the hypothesis that children low in phonological awareness do not generalize easily from one task to another (O'Connor et al., 1993, Slocum et al., 1992) and, therefore, need explicit instruction in each skill. However, findings of generalization to untaught skills found in one phonological awareness intervention

study (O'Connor et al., 1995) suggested alternative explanations such as differential length and components of instruction.

Limitations

This section discusses limitations that threaten internal and external validity of the study.

External Validity

Important limitations to external validity include time of year, length of school day, small-group setting, and intensity of instruction. The results of the present study are based on a winter-term intervention in a half-day kindergarten setting. Because of the documented reciprocal relation between letter-sound correspondence and phonological awareness, a later study may result in larger differences if the children had received an increased amount of letter-sound correspondence instruction. Children in the present study received intensive instruction that included (a) small-group instruction, (b) frequent opportunities to verbally respond as a group and as an individual, (c) immediate teacher feedback, (d) relatively quiet settings, and (e) strong, consistent positive behavior management. Findings may not generalize to large-group instruction in the regular classroom setting with less intensive curricula and procedures.

Internal Validity

The internal validity may have been compromised by too few participants for sufficient power. This may have been indicated by significant results at posttest on specific measures of phonological awareness which included four groups, whereas delayed posttest analyses included only three groups and lacked the statistical significance found at posttest.

In addition, three measurement dimensions may have limited internal validity of the present study---variability, floor, and ceiling effects. Large variability, as indicated by standard deviations that equaled or exceeded means on many measures, lessens the confidence in reliability of results. Large variability raises questions about other factors that may be influencing the test scores such as motivation, examiner effects, and testing conditions. Variability was controlled in rate of growth methodology to provide a reliable estimation of intervention effects. A weighting procedure was used so that individual slopes with large variability were reduced with a smaller weight in contrast to more stable slopes that received a higher weight (Koehler, 1995; Willett, 1988). Figure 2 illustrates two onset recognition slopes, one with high variability (i.e., 3.54) and a low weight (i.e., 0.28) and one with low variability (i.e., 0.24 and a high weight (i.e., 4.23).

Floor effects and large variability were expected at pretest on several measures (e.g., nonsense-word reading, phonemic segmentation, rapid letter-naming). Instruction appeared to lessen variability. This was indicated by standard deviations that were less than the mean for experimental groups and more than the

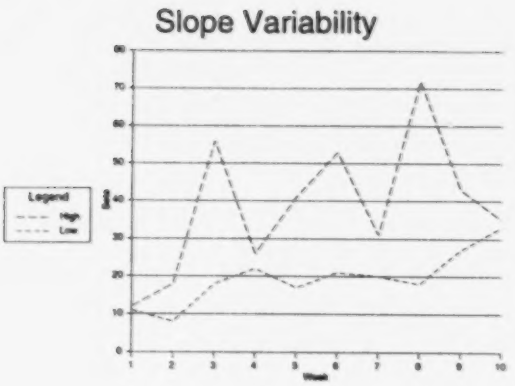

FIGURE 2. Individual slope variability on onset recognition for two children, one with high and one with low variability.

means for the control groups on such measures as phonemic segmentation at posttest and delayed posttest. Effect of instruction on phonological awareness skills was in contrast to skills that were not instructional targets in the intervention, such as nonsense-word reading and letter-naming. The standard deviations for nonsense-word reading and letter-sound naming exceeded the mean across group at posttest.

Explaining causation of growth is problematic for measures with ceiling effects. Three features of slopes as indicators of rate of growth are problematic.

1. As a ceiling is approached the slope becomes less steep.

2. A slope at ceiling may indicate no progress when the child is scoring at or near perfect scores.

3. Students with a lower intercept may appear to have a steeper rate of growth than children who began with a higher level of skill (Laimon, 1994).

Findings in the present study on rate of growth for onset recognition indicated that 17 children did not progress based on the criterion of either a negative slope or a slope of less than +0.5 (Koehler, 1995). However, examination of individual slopes and scores indicated that 3 of the 17 children identified as not progressing had slopes at or near the ceiling. Therefore, to explain the effects of instruction it is essential to examine not only the slope (i.e., beta), but also to examine the intercept and range of scores in relation to the ceiling for the measure.

Implications for Current Practice

Implications for current phonological awareness instruction in kindergarten are straightforward and consistent with prior research. Children low in phonological awareness are at-risk of reading failure and, consequently, require instruction that is both effective and efficient. Findings indicate that instruction at both the onset-rime and the phoneme level satisfy the efficacy criterion. However, there is emerging evidence that children can learn phonemic segmentation without the mediated step of instruction at the onset-rime level. The efficiencies gained through directly teaching phoneme-level skills may, therefore, prove to be an important step in designing instruction sufficiently intense and efficient for children who enter school behind in prerequisite skills. These findings will require replication with other groups of children to establish the reliability and generalizability of the findings.

It is further important to note that the instructional design of the present study and previous research generally exceed what occurs in predominant instructional materials or practice. Analyses of basal reading programs indicated that students have no opportunities to blend or segment words either at the onset or phoneme level as an auditory activity (Simmons, Gleason, Smith, Baker, Sprick, Thomas, Gunn, Chard, Plasencia-Peinado, Peinado, & Kameenui (1995). Consequently, the subtleties of findings from this particular study suggest a significant gap between research and practice. Nevertheless, findings indicate that children who require an intensity and systematicity of instruction not usually found in regular classrooms may profit from practices shaped by research-based instructional design features.

Direction for Future Research

Despite the robust amount of research investigating issues surrounding phonological awareness, many instructional design and presentation questions remain unanswered. To extend the present study, future research is needed to (a) replicate current findings, (b) examine effects of altering instructional design of the present curriculum to maximize phoneme-level instruction, (c) incorporate letter-sound correspondence and beginning reading instruction in the present study, and (d) investigate the effects of similar instruction in the regular classroom with shorter sessions over a longer period of time.

Wide variability of performance, as indicated by large standard deviations, lessened the confidence of the present findings; therefore, replication of current findings is necessary to strengthen the internal validity of the conclusions. Minimal instructional design modifications were incorporated in an effort to enhance rather than to revise the original program. However, the reliable differences indicated in the present study encourage addition of further instructional design modifications and the addition of an enhanced letter-sound/beginning reading phase. Additional modifications to the phoneme level curriculum and inclusion of an enhanced letter-sound/beginning reading phase would further investigate the effects of teaching directly at the phoneme level on phonological awareness and beginning reading development and on alphabetic understanding. Moreover, such an extension would also include longer length of treatment which may make a significant difference to students who have difficulty progressing with the program as currently designed.

To effect research into practice, it is also critical to determine the feasibility of small-group instruction in phonological awareness with regular classroom support and whether children who do not progress within the average length of intervention need more, or some other instructional variable or combination of variables, or other curricula (Blachman, 1994). Although research is establishing how to break the tyranny of time for children at-risk of reading failure (Kameenui, 1993) within a research-supported context, the examination needs to continue into the context of the regular classroom with its accompanying resources.

Conclusion

The present study added one modest, albeit important, piece of instructional design evidence important in understanding how to design effective and efficient phonological awareness instruction for kindergarten children at-risk of reading failure. Findings indicate that kindergarten children can learn as well at the phoneme level as at the onset-rime level prior to full development of alphabetic understanding.

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